DOCUMENT RESUME

ED 434 237 CE 079 237

| | |
|---|---|
| AUTHOR | Hilley, Robert; Scarberry, Terry; Kellum, Mary |
| TITLE | Diesel Technology: Brakes. Teacher Edition [and] Student Edition. |
| INSTITUTION | Multistate Academic and Vocational Curriculum Consortium, Stillwater, OK. |
| PUB DATE | 2000-00-00 |
| NOTE | 652p.; For related documents, see ED 417 277-280. |
| AVAILABLE FROM | Multistate Academic and Vocational Curriculum Consortium, 1500 West Seventh Avenue, Stillwater, OK 74074 (teacher edition, order no. 203501, $82; student edition, order no. 203502, $40). Tel: 800-654-3988 (Toll Free). |
| PUB TYPE | Guides - Classroom - Learner (051) -- Guides - Classroom - Teacher (052) |
| EDRS PRICE | EDRS Price MF03 Plus Postage. PC Not Available from EDRS. |
| DESCRIPTORS | Auto Mechanics; Course Content; *Diesel Engines; Job Skills; Learning Activities; Lesson Plans; *Motor Vehicles; Postsecondary Education; Secondary Education; *Small Engine Mechanics; Teaching Methods; Test Items; Units of Study |
| IDENTIFIERS | *Brakes (Automotive) |

ABSTRACT

This document contains teacher and student materials for a course on brakes in the diesel technology curriculum. The course consists of 12 units organized in three sections. The three units of the introductory section cover: (1) brakes; (2) wheel bearings and seals; and (3) antilock brake systems. The second section, Hydraulic Brakes, contains the following units: (4) hydraulic foundation drum brakes; (5) hydraulic foundation disc brakes; (6) hydraulic system; and (7) power assist units and related components. The final section, Air Brakes, contains the final five units of the curriculum guide: (8) air foundation brakes; (9) air supply system; (10) air service circuits; (11) special circuits; and (12) trailer air brake systems. Units in the teacher edition contain the following teacher components: suggested activities, transparency masters, teacher supplements, answers to assignment sheets, written test with answers, and unit evaluation forms. In addition to an explanation of the use of the publication, a competency profile, an instructional and task analysis, a list of related academic and workplace skills, a tools, equipment, and materials list, a list of 32 references, and a National Automotive Technicians Education Foundation crosswalk of tasks. Student components include objective sheets, information sheets, student supplements, assignment sheets, and job sheets. (KC)

********************************************************************
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
********************************************************************

ED 434 237

# Diesel Technology: Brakes

## Teacher Edition

## Student Edition

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)

☑ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

PERMISSION TO REPRODUCE AND
DISSEMINATE THIS MATERIAL IN
MICROFICHE ONLY HAS BEEN GRANTED BY

A Pratt

TO THE EDUCATIONAL RESOURCES
INFORMATION CENTER (ERIC)

2B

CE079237

BEST COPY AVAILABLE

# Diesel Technology

## Brakes

MAVCC

Teacher Edition

[illegible]

BEST COPY AVAILABLE

# Diesel Technology: Brakes

## Teacher Edition

Written by

Robert Hilley
Terry Scarberry
Mary Kellum

Project Coordinated by

Mary Kellum
Jane Huston

Developed by

The Multistate Academic and Vocational Curriculum Consortium, Inc.
(MAVCC)

Board of Directors

Jim Fliehler, Iowa, Chair
Jean McEntire, Arkansas
Ben Clay, Kansas
Mervin Birdwell, Louisiana
Dana Tannehill, Missouri
Kimberly Sadler, Oklahoma
Larry Nelson, South Dakota
Lynne Cohen, Tennessee
Emmett Eary, Texas

Clark R. Harris, Executive Director

00-10432 203501

©2000 by the Multistate Academic and Vocational Curriculum Consortium, Inc.

All rights reserved. No part of this book may be reproduced in any form or by any means without written permission from the publisher.

Printed in the United States of America by the
Oklahoma Department of Vocational-Technical Education
Stillwater, OK 74074-4364

For more information, contact the
Multistate Academic and Vocational Curriculum Consortium
1500 West Seventh Avenue
Stillwater, OK 74074-4364

E-mail:mavccweb@okvotech.org
Internet: http://www.mavcc.org
Phone: (800) 654-3988 or (405) 743-5578

The Multistate Academic and Vocational Curriculum Consortium does not discriminate on the basis of race, creed, color, national origin, sex, age, religion, veteran status, or qualified handicap.

# *Diesel Technology: Brakes*

Teacher Edition

## Table of Contents

- **Introductory Pages**

Foreword ........ v
Acknowledgements ........ vii
Use of introductory materials ........ ix
Use of this publication ........ xi
Competency profile ........ xv
Instructional/task analysis ........ xix
Academic and workplace skills (classifications and definitions) ........ xxvii
Related academic and workplace skills list ........ xxix
Tools, equipment, and materials list ........ xlvii
References ........ xlix
NATEF Crosswalk ........ li

- **Teacher Pages for Each Unit**
- **Student Pages** **DT:B**

**SECTION A: INTRODUCTION**

Unit 1-A: Introduction to Brakes ........ A 1
Unit 2-A: Wheel Bearings and Seals ........ A 25
Unit 3-A: Antilock Brake Systems ........ A 47

**SECTION B: HYDRAULIC BRAKES**

Unit 1-B: Hydraulic Foundation Drum Brakes ........ B 1
Unit 2-B: Hydraulic Foundation Disc Brakes ........ B 23
Unit 3-B: Hydraulic System ........ B 43
Unit 4-B: Power Assist Units and Related Components ........ B 95

**SECTION C: AIR BRAKES**

Unit 1-C: Air Foundation Brakes ........ C 1
Unit 2-C: Air Supply System ........ C 47
Unit 3-C: Air Service Circuits ........ C 85
Unit 4-C: Special Circuits ........ C 115
Unit 5-C: Trailer Air Brake Systems ........ C 175

# Foreword

When MAVCC began the process for revising its diesel mechanics series, we wanted to develop instructional materials that would provide students with the cognitive (knowing), psychomotor (doing), and affective (attitude) skills necessary to be successful in the diesel trade and that would address the emerging technology in the field. With the help of extremely qualified teachers, industry representatives, and writers, our new diesel technology series offers secondary and postsecondary students an excellent opportunity for learning required skills in the diesel industry.

The series aligns with the medium/heavy duty truck task list developed by the National Automotive Technicians Education Foundation (NATEF) and used by the National Institute for Automotive Service Excellence (ASE) in the certification of medium/heavy duty truck technicians. Our series will address all but one of the ASE certification areas, gasoline engines, and will include the following publications: *Introduction, Safety Skills, Workplace Skills, Brakes, Steering and Suspension, Engines, Electrical and Electronic Systems, Air Conditioning, Drive Trains, and Hydraulics.* Each publication will include a matrix showing where the NATEF tasks are being taught.

These instructional materials are designed for student use and to assist teachers in organizing and improving instruction. Their design is based on the curriculum alignment concept of first stating the objectives (objective sheet), developing instructional strategies for teaching to those objectives (information, assignment, and job sheets), and assessing to those same objectives (criterion-referenced evaluation instruments).

As with all MAVCC publications, teachers are encouraged to localize and personalize these materials to meet the needs of individual students, the community, and prospective employers. Teachers are also encouraged to develop strategies for motivating their students.

A chart which classifies and defines each of the academic and workplace skills and competencies has been included in the teacher edition and reflects key elements from *What Work Requires of Schools: A SCANS Report for America 2000*, a 1991 study by the U.S. Department of Labor; *Workplace Basics: The Skills Employers Want*, a three-year study conducted jointly by the American Society for Training and Development (ASTD) and the United States Department of Labor (DOL); and other national and state sources. These tools have been provided in an effort to help educators identify and document where basic academic and workplace skills are being taught. By reinforcing these skills, the teacher should assist students in improving their employability skills.

Special attention should be given to the matrix identifying basic academic and workplace skills being reinforced in these instructional materials as well as the teacher suggestions on ways to reinforce these skills found in the teacher pages for each unit.

As you use these instructional materials, we hope that you will find that they contribute to the quality of your program. If any problems occur or if you have any suggestions for improvement of the materials, please call or write us.

Jim Fliehler, Chair
MAVCC Board of Directors

Clark R. Harris
MAVCC Executive Director

# Acknowledgements

Appreciation is extended to the many individuals who contributed their time and talent to the original development of *Diesel Technology: Brakes*.

The content of this publication was planned by the following members of the MAVCC diesel revision committee:

Dave Barbieri, instructor
Lee High School
Tyler/Overton, TX

Jerry Bisbee, dealer trainer
Oklahoma City Freightliner, Inc.
Oklahoma City, OK

Lane Eichhorn, instructor
Parkland College
Champaign, IL

Danny Fisher, instructor
Pulaski Technical College
North Little Rock, AR

John R. Harris, retired instructor
Panora, IA

David Kennedy, instructor
T.H. Harris Technical Institute
Opelousas, LA

Orville Manuel, automotive program specialist
Oklahoma Department of Vocational
and Technical Education
Stillwater, OK

Roger Miller, retired instructor and owner of
Diesel Fuel Injection Service
Salina, KS

Terry Scarberry, instructor
Gordon Cooper Area Vo-Tech Center
Shawnee, OK

Greg Tatro, Detroit Diesel trainer
United Engines
Oklahoma City, OK

A special thank you to the following manufacturers and organizations for providing technical information and illustrations that appear in this publication:

AlliedSignal T.B.S. Company
Ford Motor Company
Federal Mogul
Freightliner Corporation
General Motors Corporation
Haldex Midland Services
Mack Trucks, Inc.
Meritor Automotive, Inc.
Navistar International Transportation Corp.
Peterbilt/PACCAR

Portions of materials contained herein have been reprinted with permission of General Motors Corporation, Service Operations.

Thanks are also given to Jane Huston for her assistance with committee facilitation.

Special appreciation is extended to Stacy Lee for her excellent work as the electronic publishing technician on this publication.

Appreciation is extended to the Graphics Division of the Oklahoma Department of Vocational and Technical Education for the artwork and printing of this text, especially Suzi Morris, Candy Haun and Willie Tannahill.

## Use of Introductory Materials

Introductory materials are included in the teacher edition only and contain useful information to assist administrators and teachers in planning for instruction.

In addition to the general information such as the table of contents, foreword, and acknowledgements, information is included on the following:

1. **Use of this publication**—Explains the components of a unit of instruction and how they should be used as part of the teaching/learning process.
2. **Competency profile**—Provides a record of student performance for each task included in a unit of instruction. This becomes a part of the student's permanent records and should be utilized when directing the student toward employment opportunities.
3. **Instructional/task analysis**—Provides a quick review of contents of the publication; identifies cognitive (knowledge) skills and psychomotor (doing) skills addressed in each unit of instruction.
4. **Related academic and workplace skills list**—Classifies unit tasks (assignment sheets and job sheets) according to related academic and workplace skills and competencies being reinforced. Skill areas reflected by skill groups, sub skills, and definitions have been identified using *What Work Requires of Schools: A SCANS Report for America 2000* and *Workplace Basics: The Skills Employers Want.*
5. **Tools, equipment, and materials list**—Provides a comprehensive list of those items needed to successfully complete the assignment sheets and/or job sheets; assists administrator/teacher in determining program costs.
6. **Reference list**—Provides a comprehensive list of resources used in the development of this publication.
7. **NATEF crosswalk**—Identifies the National Automotive Technicians Education Foundation, Inc., (NATEF) tasks covered in this publication and lists specifically where these tasks are located by unit number and assignment or job sheet number. This is provided for programs and students preparing for ASE certification.

As you use these materials, it is hoped that they will provide useful information to meet a variety of needs.

# Use of This Publication

*Diesel Technology: Brakes* contains twelve units of instruction. For the teacher edition, the pages are divided into teacher pages and student pages. These include the following:

Teacher Pages

- Suggested Activities
- Transparency Masters*
- Teacher Supplements*
- Answers to Assignment Sheets*
- Written Test
- Answers to Written Test
- Unit Evaluation Form

Student Pages

- Objective Sheet
- Information Sheet
- Student Supplements*
- Assignment Sheets*
- Job Sheets*

* *Designates components that may not appear in every unit of instruction*

The complete teacher edition consists of both teacher pages and student pages, as well as the introductory pages. Student pages focus on measurable and observable learning outcomes. Teacher pages provide evaluation tools and suggestions on ways to supplement, localize, personalize, and motivate in order to present a complete teaching/learning process.

MAVCC instructional materials are competency-based, not time-based. Students should be allowed to work until they master each competency.

Units of instruction are designed for use in more than one lesson or class period. Careful study of each unit of instruction by the teacher will help to determine the following:

- Amount of materials that can be covered in each class period
- Skills that must be demonstrated
- Amount of class time needed for demonstrations
- Amount of time needed for student practice and return demonstrations of mastered skills
- Supplies and equipment required for assignment sheets and job sheets
- Supplementary materials (videotapes, kits, reference books, etc.) that must be ordered
- Resource people who must be contacted

**Suggested activities** (teacher component)

The suggested activities assist teachers during the preparation stage of the teaching/learning process by providing an instructional plan, teaching suggestions, and a list of supplemental resources. Ways to integrate academic and workplace skills have been included in the teacher suggestions, and skill areas have been noted in bold. The teacher should read the suggested activities before teaching the units. Time should also be allowed to obtain supplemental materials, prepare audiovisual materials, and contact outside resources. Duties of the teacher will vary according to the particular unit.

Instructions for evaluating student performance on the job sheets are also included in the suggested-activities section. Teachers should select and discuss with students the rating scale that will be used.

## Use of This Publication

To assist a teacher in obtaining suitable supplemental materials, references used in the development of each unit are listed in this component, along with suggested supplemental resources such as books, posters, pamphlets, videotapes, and computer software.

**Transparency masters** (teacher component)

Transparency masters are used to direct the students' attention to the topic of classroom discussion. They may provide illustrations, charts, schematics, or additional information needed to clarify and reinforce objectives included in the unit of instruction.

**Teacher supplements** (teacher component)

Teacher supplements are optional materials for the teacher to use. They have three purposes: to provide the teacher with higher level materials to stretch the advanced student, with remedial information or practice to assist the less-advanced student, and with state-of-the-art information in which the teacher may not have background or with information that is not readily available in other books. Some teacher supplements may be duplicated for student use and are marked accordingly.

**Answers to assignment sheets** (teacher component)

These are designed to assist the teacher in evaluation of student performances.

**Written test** (teacher component)

This component provides criterion-referenced evaluation of every cognitive objective listed in the unit of instruction. The written test may be duplicated for student use. If objectives have been added, deleted, or modified, appropriate changes should be made on the written test. Tests may be divided into shorter tests covering three or four objectives at a time and given soon after those objectives have been covered. A selection of test items from the units covered may be used for final tests at the end of each term if desired.

**Answers to written test** (teacher component)

These are designed to assist the teacher in evaluation of student performances.

**Unit evaluation form** (teacher component)

This sheet provides teachers with a record of each student's performance on a unit of instruction. It includes space for assignment sheet ratings, job sheet ratings, written test scores, and teacher comments. The unit evaluation form may be duplicated.

**Objective sheet** (student component)

Each unit of instruction is based on performance objectives which state the goals for successful completion of the course. These performance objectives are stated in two forms: unit objectives which state the expected performance of each student after completion of the unit of instruction, and specific objectives which state what the student must do to reach the unit objective.

The objectives should be stressed throughout the teaching/learning process. This will help answer any questions concerning performance requirements for each instructional unit. The objectives can also help determine teaching strategies and instructional methods. Teachers should prepare for each unit by deciding how each objective can best be taught.

## Use of This Publication

Teachers should feel free to modify, delete, or add objectives in order to meet the needs of the students and community. When objectives are added, the teacher should remember to supply the needed information, assignment and/or job sheets, and criterion test items.

**Information sheet** (student component)

The information sheet provides the content essential for meeting the cognitive (knowledge) objectives of the unit. Teachers will find that the information sheet serves as an excellent guide for presenting background knowledge necessary to develop the skills specified in the unit objective. Students should read the information sheet before the information is discussed in class. Space is provided in margins for students and teachers to add notes that supplement, localize, personalize, or provide information for the teaching of each objective.

**Student supplements** (student component)

The information presented in a student supplement may consist of tables, charts, written information, forms, or other information students will need in order to complete one or more of the assignment and/or job sheets. Students are not directly tested over the information presented in a supplement; however, their ability to apply this information may be evaluated in the completion of assignment sheets and/or job sheets.

**Assignment sheets** (student component)

Assignment sheets provide students with paper and pencil activities that give students the opportunity to make practical application of the knowledge in the information sheet. Criteria are provided to objectively evaluate student performance.

**Job sheets** (student component)

Job sheets are an important segment of each unit. Job sheets provide potential employers with a picture of the skills being taught during training and the performances that might reasonably be expected from an individual who has had this training.

The job sheets provide criteria to objectively evaluate student performance, a list of required equipment and materials, and a step-by-step procedure for performing a psychomotor skill. The teacher should discuss the equipment and materials available in the classroom, laboratory, or shop and demonstrate the procedure prior to having students practice the procedure. When a student is ready to be evaluated, the teacher should follow instructions for evaluating student performance which may be found in the teacher edition (suggested activities component).

## *Diesel Technology: Brakes*

## Competency Profile

**Name:** ______________________________

**Directions:** Evaluate the student using the rating scale below. Write the appropriate number to indicate the degree of competency achieved. The descriptions associated with each of the numbers focuses on a level of student performance for each of the tasks listed. The written test scoreline is provided for optional teacher use. It may not be applicable in all cases.

Option A

Rating scale:
4 – Skilled – Can perform job with no additional training
3 – Moderately Skilled – Has performed job during training program; limited additional training may be required.
2 – Limited Skill – Has performed job during training program; additional training is required to develop skill.
1 – Unskilled – Is familiar with process, but is unable to perform job.
0 – No Exposure [illegible] information or practice provided during training program, complete training required.
NA – Non-applicable.

Option B

Yes – Can perform with no additional training
No – Is unable to perform satisfactorily

### SECTION A: INTRODUCTION

Unit 1-A: Introduction to Brakes

_______ 1. Diagnose and determine possible causes of general brake problems.
_______ 2. Identify features for assigned vehicle.
_______ 3. Move vehicle and prepare for service.
_______ 4. Check brake fluid level and condition and inspect for leaks.
_______ 5. ______________________________

_______ Written Test Score

Unit 2-A: Wheel Bearings and Seals

_______ 1. Evaluate worn and damaged wheel bearings and seals.
_______ 2. Select appropriate replacement wheel bearings and seals.
_______ 3. Remove, inspect, clean, replace, and adjust wheel bearings and seals.
_______ 4. ______________________________

_______ Written Test Score

Unit 3-A: Antilock Brake Systems

_______ 1. Diagnose and determine possible causes of ABS problems.
_______ 2. Inspect, test, and service an antilock brake system.
_______ 3. Troubleshoot antilock brake system problems.
_______ 4. ______________________________

_______ Written Test Score

# Competency Profile

## SECTION B: HYDRAULIC BRAKES

### Unit 1-B: Hydraulic Foundation Drum Brakes

_______ 1. Remove, clean, inspect, and measure a brake drum.
_______ 2. Remove, inspect, and replace brake shoes and related hardware.
_______ 3. Replace brake drum and adjust brake clearance.
_______ 4. ______________________________

_______Written Test Score

### Unit 2-B: Hydraulic Foundation Disc Brakes

_______ 1. Remove, clean, and inspect a caliper and pad assembly.
_______ 2. Inspect, measure, remove, and reinstall a rotor assembly.
_______ 3. Reinstall caliper and pad assembly and check brake operation.
_______ 4. ______________________________

_______Written Test Score

### Unit 3-B: Hydraulic System

_______ 1. Interpret hydraulic system diagrams.
_______ 2. Interpret brake light system circuit diagrams.
_______ 3. Test hydraulic system and inspect for leaks; determine needed repairs.
_______ 4. Bleed and/or flush the hydraulic brake system.
_______ 5. Remove, inspect, and repair or replace the hydraulic brake valve.
_______ 6. Remove, inspect, and repair or replace the master cylinder.
_______ 7. Create flare and double flare fittings.
_______ 8. Remove and repair or replace the wheel cylinder.
_______ 9. Check and adjust the parking brake.
_______10. Check operation of brake light switch; adjust or replace as needed.
_______11. ______________________________

_______Written Test Score

### Unit 4-B: Power Assist Units and Related Components

_______ 1. Inspect and test the power assist system and emergency brake back-up system; determine needed repairs.
_______ 2. Remove, inspect, and repair or replace the power assist unit.
_______ 3. Check operation of brake failure lights and braking warning devices; repair or replace as needed.
_______ 4. ______________________________

_______Written Test Score

## SECTION C: AIR BRAKES

### Unit 1-C: Air Foundation Brakes

_______ 1. Inspect, service, and adjust slack adjuster on front axle.
_______ 2. Inspect, test, service, and replace service brake chamber.
_______ 3. Remove, inspect, and replace brake shoes, drum, and hardware for s-cam drum foundation brakes.

_______ 4. Remove, inspect, and replace brakes shoes, drum and hardware for wedge-type drum foundation brakes.
_______ 5. Inspect, clean, and measure brake calipers, pads, and rotors; replace pads if needed.
_______ 6. ____________________

_______Written Test Score

Unit 2-C: Air Supply System

_______ 1. Identify and connect components in an air supply system.
_______ 2. Service the reservoir and check valve function, build-up time, and cut-out pressure.
_______ 3. Inspect and service belt-driven compressor and associated lines.
_______ 4. Inspect, service, and time gear-driven compressor, valves, and associated lines.
_______ 5. Inspect and service air dryer system; repair or replace as needed.
_______ 6. ____________________

_______Written Test Score

Unit 3-C: Air Service Circuits

_______ 1. Identify and connect components in the air service circuits.
_______ 2. Inspect and test brake application (foot) valve, fittings, and mounts; adjust or replace as needed.
_______ 3. Inspect and test stop light circuit switches, wiring, and connectors; repair or replace as needed.
_______ 4. Inspect and test relay valve; replace as needed.
_______ 5. Inspect and test quick release valve; replace as needed.
_______ 6. ____________________

_______Written Test Score

Unit 4-C: Special Circuits

_______ 1. Identify and connect components in a truck brake system.
_______ 2. Identify and connect components in a tractor brake system.
_______ 3. Inspect and test parking brake hand (control) valve; replace as needed.
_______ 4. Inspect and test inversion valve; replace as needed.
_______ 5. Inspect and test anti-compounding circuit equipped with Quick Release (QR) 1-C; replace as needed.
_______ 6. Inspect and test trailer air supply valve; replace as needed.
_______ 7. Inspect and test trailer brake control valve (hand valve); replace as needed.
_______ 8. Inspect and test tractor protection valve; replace as needed.
_______ 9. Check operation of parking brake; remove, inspect, and replace parking brake (spring brake) chamber as needed.
_______10. ____________________

_______Written Test Score

## Competency Profile

Unit 5-C: Trailer Air Brake Systems

_______ 1. Identify and connect components of a trailer full function air brake system.
_______ 2. Inspect and test tractor trailer gladhands; repair or replace as needed.
_______ 3. Inspect and test trailer brake full function valve; replace as needed.
_______ 4. ______________________________

_______Written Test Score

**COMMENTS:** ______________________________

______________________________

______________________________

______________________________

Evaluator: ______________________ Date: ______________

Permission to duplicate this profile is granted.

*Diesel Technology: Brakes*

## Instructional/Task Analysis

**Related Information: What the Student Should Know**

**Application: What the Student Should Be Able to Do**

### SECTION A: INTRODUCTION

Unit 1-A: Introduction to Brakes

1. Terms and definitions
2. Purposes of the brake system
3. Scientific principles that affect brake systems
4. Types of brake systems
5. Operation of a hydraulic brake system
6. Operation of an air brake system
7. Comparison of hydraulic and air brake systems
8. Types of brake fluid
9. Guidelines for handling and storing brake fluid
10. Purposes of troubleshooting and failure analysis
11. Steps in failure analysis
12. Signs of brake failure
13. Common causes of brake failure
14. Safety procedures to follow when working on brakes
15. Overview of asbestos and safety guidelines to follow when working around asbestos
16. Specialty brake tools and equipment
17. Diagnose and determine possible causes of general brake problems
18. Identify features for assigned vehicle
19. Move vehicle and prepare for service
20. Check brake fluid level and condition and inspect for leaks

## Instructional/Task Analysis

**Related Information: What the Student Should Know** | **Application: What the Student Should Be Able to Do**

### Unit 2-A: Wheel Bearings and Seals

**Related Information: What the Student Should Know**

1. Terms and definitions
2. Purposes of wheel bearings
3. Parts of a wheel bearing
4. Parts of wheel and hub assemblies
5. Common wheel bearing defect
6. Reasons for bearing failures
7. Wheel bearing problems
8. Types of wheel bearing lubricants
9. Guidelines for servicing wheel bearings
10. Guidelines for adjusting wheel bearings
11. Purposes of wheel seals
12. Types of wheel seals
13. Causes of sealing failure
14. Guidelines for installing wheel seals

**Application: What the Student Should Be Able to Do**

15. Evaluate worn and damaged wheel bearings and seals
16. Select appropriate replacement wheel bearings and seals
17. Remove, inspect, clean, replace, and adjust wheel bearings and seals

### Unit 3-A: Antilock Brake Systems

**Related Information: What the Student Should Know**

1. Terms and definitions
2. Purposes of antilock brake systems
3. Basic parts of an antilock brake system
4. Basic operation of an antilock brake system
5. Ways to describe antilock brake systems
6. ABS time line
7. Methods of testing ABS valves
8. Most common problems associated with antilock brake systems
9. Signs of antilock brake failure

**Application: What the Student Should Be Able to Do**

10. Diagnose and determine possible causes of ABS problems
11. Inspect, test, and service an antilock brake system
12. Troubleshoot antilock brake system problems

## Instructional/Task Analysis

**Related Information: What the Student Should Know**

**Application: What the Student Should Be Able to Do**

## SECTION B: HYDRAULIC BRAKES

### Unit 1-B: Hydraulic Foundation Drum Brakes

1. Terms and definitions
2. Components of a drum brake assembly
3. Functions of drum brake assembly components
4. Drum and hub assembly defects
5. Parts of a brake shoe
6. Functions of brake shoe parts
7. Types of brake shoe applications
8. Brake shoe materials
9. Brake shoe defects
10. Drum brake hardware and their uses
11. Adjustment of drum brake assemblies
12. Conditions to inspect in drum brake adjustment systems
13. Remove, clean, inspect, and measure a brake drum
14. Remove, inspect, and replace brake shoes and related hardware
15. Replace brake drum and adjust brake clearance

### Unit 2-B: Hydraulic Foundation Disc Brakes

1. Terms and definitions
2. Parts of a front disc brake
3. Parts of a rear disc brake
4. Parts of a brake caliper
5. Functions of disc brake assembly components
6. Types of brake calipers
7. Rotor defects
8. Methods of assembling brake pads
9. Brake pad defects

## Instructional/Task Analysis

### Unit 2-B: Hydraulic Foundation Disc Brakes (continued)

**Related Information: What the Student Should Know**

10. Methods of determining wear on brake pads
11. Functions of noise suppressants and hardware components of a brake pad
12. Safety guidelines for disc brake service

**Application: What the Student Should Be Able to Do**

13. Remove, clean, and inspect a caliper and pad assembly
14. Inspect, measure, remove, and reinstall a rotor assembly
15. Reinstall caliper and pad assembly and check brake operation

### Unit 3-B: Hydraulic System

**Related Information: What the Student Should Know**

1. Terms and definitions
2. Components of a hydraulic system
3. Functions of hydraulic system components
4. Parts of a brake pedal
5. Parts of a combination brake valve
6. Functions of a combination brake valve
7. Brake valve defects
8. Methods of bleeding the hydraulic system
9. Parts of a master cylinder
10. Types of wheel cylinders
11. Types of brake lines
12. Types of brake line connections
13. Types of parking brakes
14. Switch operation for brake lights and brake failure warning lights

**Application: What the Student Should Be Able to Do**

15. Interpret hydraulic system diagrams
16. Interpret brake light system circuit diagrams
17. Test hydraulic system and inspect for leaks; determine needed repairs
18. Bleed and/or flush the hydraulic brake system
19. Remove, inspect, and repair or replace the hydraulic brake valve
20. Remove, inspect, and repair or replace the master cylinder
21. Create flare and double flare fittings
22. Remove and repair or replace the wheel cylinder
23. Check and adjust the parking brake
24. Check operation of brake light switch; adjust or replace as needed

## Instructional/Task Analysis

**Related Information: What the Student Should Know**

**Application: What the Student Should Be Able to Do**

### Unit 4-B: Power Assist Units and Related Components

1. Terms and definitions
2. Purpose of a power assist unit
3. Basic types of power assist units
4. Parts of a vacuum power assist unit
5. Parts of a hydraulic power assist unit
6. Functions of the basic parts of power assist units
7. Most common problems associated with power assist units
8. Adjustment of the brake booster push rod
9. Operation of emergency back-up systems
10. Use of brake fluid and power steering fluid on power assist units
11. Inspect and test the power assist system and emergency brake back-up system; determine needed repairs
12. Remove, inspect, and repair or replace the power assist unit
13. Check operation of brake failure lights and braking warning devices; repair or replace as needed

## SECTION C: AIR BRAKES

### Unit 1-C: Air Foundation Brakes

1. Terms and definitions
2. Basic components that make up air foundation brakes
3. Types of air foundation brakes
4. Parts of a cam foundation brake
5. Parts of a wedge foundation brake
6. Parts of a disc foundation brake
7. Types of shoe assembly anchors
8. Brake linings, blocks, and pads
9. Guidelines for relining brakes
10. Types of brake drum assembly arrangements
11. Types of slack adjusters

## Instructional/Task Analysis

| Related Information: What the Student Should Know | Application: What the Student Should Be Able to Do |
|---|---|
| **Unit 1-C: Air Foundation Brakes (continued)** | |
| 12. Advantages of automatic slack adjusters | 19. Inspect, service, and adjust slack adjuster on front axle |
| 13. Parts of slack adjusters | |
| 14. Guidelines for working on slack adjusters | 20. Inspect, test, service, and replace service brake chamber |
| 15. Parts of a service brake chamber | 21. Remove, inspect, and replace brake shoes, drum, and hardware for s-cam drum foundation brakes |
| 16. Operation of a typical service brake chamber | |
| 17. Guidelines for working on service brake chambers | 22. Remove, inspect, and replace brake shoes, drum, and hardware for wedge-type drum foundation brakes |
| 18. Main check points for inspecting foundation components | 23. Inspect, clean, and measure brake calipers, pads, and rotors; replace pads if needed |
| **Unit 2-C: Air Supply System** | |
| 1. Terms and definitions | |
| 2. Components of the air supply system | |
| 3. Basic functions of the air supply components | |
| 4. Parts of a compressor | |
| 5. Characteristics of compressors | |
| 6. Loading and unloading process | |
| 7. Characteristics of governors | |
| 8. Methods of providing clean air to the compressor | |
| 9. Parts and ports of an air dryer (desiccant type) | |
| 10. Characteristics of air dryers | |
| 11. Cycles that occur in the operation of the air dryer | |
| 12. Optional devices that may be used on supply systems | |
| 13. Characteristics of supply reservoirs | |

## Instructional/Task Analysis

**Related Information: What the Student Should Know**

**Application: What the Student Should Be Able to Do**

### Unit 2-C: Air Supply System (continued)

14. Valves and switches used on the air supply system
15. Functions of supply system valves and switches
16. Basic characteristics of air brake valves
17. Types of lines used on the air supply system

18. Identify and connect components in an air supply system
19. Service the reservoir and check valve function, build-up time, and cut-out pressure
20. Inspect and service belt-driven compressor and associated lines
21. Inspect, service, and time gear-driven compressor, valves, and associated lines.
22. Inspect and service air dryer system; repair or replace as needed

### Unit 3-C: Air Service Circuits

1. Terms and definitions
2. Comparison of service circuits
3. Components of the secondary service circuit
4. Components of the primary service circuit
5. Functions of service circuit components
6. Parts of a brake application valve and treadle assembly
7. Characteristics of the brake application valve
8. Parts and ports of a quick release valve
9. Parts and ports of a relay valve
10. Other valves that may be used on service circuits

11. Identify and connect components in the air service circuits
12. Inspect and test brake application (foot) valve, fittings, and mounts; adjust or replace as needed
13. Inspect and test stop light circuit switches, wiring, and connectors; repair or replace as needed
14. Inspect and test relay valve; replace as needed
15. Inspect and test quick release valve; replace as needed

### Unit 4-C: Special Circuits

1. Terms and definitions
2. Purposes of special circuits for a truck brake system
3. Components of the parking circuit
4. Components of the emergency circuit
5. Components of the anti-compounding circuit

## Instructional/Task Analysis

**Related Information: What the Student Should Know**

**Application: What the Student Should Be Able to Do**

### Unit 4-C: Special Circuits (continued)

6. Conditions in which compounding can occur
7. Functions of special circuit components of the truck brake system
8. Special circuit components of the truck brake system
9. Parts and ports of a system park control valve
10. Characteristics of the system park control valve
11. Ports of an inversion valve
12. Parts and ports of a spring brake (rear axles)
13. Operation of spring brakes
14. Regulatory requirements of parking and emergency circuits (FMVSS121)
15. Components of the tractor brake system
16. Functions of truck/tractor circuit components
17. Parts and ports of a hand control valve
18. Parts and ports of a tractor protection valve
19. Parts and ports of a trailer air supply valve

20. Identify and connect components in a truck brake system
21. Identify and connect components in a tractor brake system
22. Inspect and test parking brake hand (control) valve; replace as needed
23. Inspect and test inversion valve; replace as needed
24. Inspect and test anti-compounding circuit equipped with Quick Release (QR) 1-C; replace as needed
25. Inspect and test trailer air supply valve; replace as needed
26. Inspect and test trailer brake control valve (hand valve); replace as needed
27. Inspect and test tractor protection valve; replace as needed
28. Check operation of parking brake; remove, inspect, and replace parking (spring brake) chamber as needed

### Unit 5-C: Trailer Air Brake Systems

1. Terms and definitions
2. Types of gladhands
3. Components of the trailer air brake system
4. Functions of the components of the trailer air brake system
5. Components of the dollie system
6. Components of the trailer full function valve system
7. Ports of a full function valve

8. Identify and connect components of a trailer full function air brake system
9. Inspect and test tractor trailer gladhands; repair or replace as needed
10. Inspect and test trailer brake full function valve; replace as needed

# Academic and Workplace Skills
# (Classifications and Definitions)

| Skill Group | Sub Skill | Description |
|---|---|---|
| Basic skills | Reading | Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task. |
| | Writing | Communicating a thought, idea, or fact in written form in a clear, concise manner. |
| | Arithmetic/ mathematics | Performing basic computations, applying estimating and reasoning skills, and solving practical problems using a variety of mathematical techniques. |
| | Science | Applying knowledge learned through study and practice that is based on scientific principles, methods, and techniques. |
| | Listening | Receiving, interpreting, and responding to verbal messages and other cues. |
| | Speaking | Communicating a thought, idea, or fact verbally in a clear, concise manner. |
| Thinking skills | Creative thinking | Using imagination to generate new ideas. |
| | Decision making | Specifying goals and constraints, generating alternatives, considering risks, and evaluating and choosing the best alternative. |
| | Problem solving | Recognizing and defining problems, devising and implementing a plan of action, and tracking and evaluating results. |
| | Seeing things in the mind's eye | Mentally organizing and processing symbols, pictures, graphs, and other information. |
| | Knowing how to learn | Using efficient learning techniques to acquire and apply new knowledge and skills. |
| | Reasoning | Applying a rule or principle underlying the relationship between two or more objects when solving a problem. |
| Personal management skills | Responsibility | Exerting a high level of effort towards goal attainment, working hard to become excellent at doing tasks by setting high standards, paying attention to details, and displaying a high level of concentration. |
| | Self-esteem | Developing self-confidence and maintaining a positive view of self. |
| | Career awareness, development, and mobility | Assessing self accurately, setting personal goals, establishing and implementing a plan, and monitoring progress. |
| | Integrity/honesty | Choosing an ethical course of action when faced with making a decision that may break with personal or societal values and recognizing the impact of violating these beliefs and codes on an organization, self, and others. |
| | Organizational effectiveness | Adapting to the organization's goals, values, culture, and traditional modes of operation. |

BEST COPY AVAILABLE

## Academic and Workplace Skills

| Skill Group | Sub Skill | Description |
|---|---|---|
| Interpersonal skills | Teamwork | Working cooperatively with others to reach a common goal. |
| | Coaching | Helping others learn new skills. |
| | Leadership | Communicating ideas to justify position; accepting responsibility for others; and encouraging, persuading, convincing, or otherwise motivating an individual or group. |
| | Negotiation | Resolving conflict between two or more individuals through discussion and compromise. |
| | Customer service | Working and communicating with customers to satisfy their expectations. |
| | Cultural diversity | Working well with men and women with a variety of ethnic, social, or educational backgrounds. |
| Information | Acquisition and evaluation | Identifying need for data, obtaining it from existing sources or creating it, and evaluating its relevance and accuracy. |
| | Organization and storage | Organizing, processing, and maintaining written or computerized records and other forms of information in a systematic way. |
| | Interpretation | Selecting and analyzing information and communicating the results to others. |
| | Processing | Using computers to acquire, organize, analyze, and communicate information. |
| Systems | Interrelationships | Knowing how social, organizational, and technological systems work and operate effectively. |
| | Monitoring | Distinguishing trends, predicting impact of actions on system operations, diagnosing deviations in systems' performance, and correcting malfunctions. |
| | Modification and design | Making suggestions to modify existing systems to improve products or services, and developing new or alternative systems. |
| Technology | Selection | Choosing procedures, tools, or equipment including computers and related technologies. |
| | Application | Demonstrating proper procedures for setting up and operating equipment. |
| | Maintenance and troubleshooting | Preventing, identifying, or solving problems with equipment, including computers and other technologies. |

# Related Academic and Workplace Skills For *Diesel Technology: Brakes*

## SECTION A: INTRODUCTION

### Unit 1-A: Introduction to Brakes

| Task | Skill Group | Sub Skill | Description |
|---|---|---|---|
| Diagnose and determine possible causes of general brake problems (A.S. 1) | Basic skills | Reading | Locates pertinent information in service manuals and troubleshooting guides; applies information to job performance |
| | Thinking skills | Problem solving | Identifies possible reasons for problem |
| | Information | Acquisition and evaluation | Acquires information from manuals and guides |
| Identify features for assigned vehicle (A.S. 2) | Basic skills | Reading | Locates pertinent information in manuals and logs |
| | Thinking skills | Reasoning | Uses logic to draw conclusions from available information |
| | Information | Acquisition and evaluation | Acquires information from manuals and inspection |
| Move vehicle and prepare for service (J.S. 1) | Basic skills | Reading | Comprehends written information and applies it to a task; uses operator's manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all appropriate information |
| | Thinking skills | Reasoning | Applies rules and principles to a new situation |
| | Personal management skills | Responsibility | Follows shop safety rules |
| Check brake fluid level and condition and inspect for leaks (J.S. 2) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all appropriate information |
| | Thinking skills | Problem solving | Identifies problems; draws conclusions from observations; determines repairs and/or replacements needed |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Maintenance and troubleshooting | Inspects, repairs, and replaces components/fluid as required |

## Related Academic and Workplace Skills

| Task | Skill Group | Sub Skill | Description |
|---|---|---|---|
| **Unit 2-A: Wheel Bearings and Seals** | | | |
| Evaluate worn and damaged wheel bearings and seals (A.S. 1) | Basic skills | Reading | Comprehends written information and applies it to a task |
| | | Writing | Presents answers in a clear and understandable form; describes condition accurately; uses technical words |
| | Thinking skills | Decision making | Evaluates type and amount of wear to determine reusability or replacement |
| | Technology | Maintenance and troubleshooting | Inspects and evaluates component's condition |
| Select appropriate replacement wheel bearings and seals (A.S. 2) | Basic skills | Reading | [illegible]cates pertinent information in service manuals and guides |
| | Thinking skills | Reasoning | Uses logic to draw conclusions from available information |
| Remove, inspect, clean, replace, and adjust wheel bearings and seals (J.S. 1) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all appropriate information |
| | Thinking skills | Reasoning | Applies rules and principles to a new situation |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Cleans, inspects, replaces, and adjusts components as required |
| **Unit 3-A: Antilock Brake Systems** | | | |
| Diagnose and determine possible causes of ABS problems (A.S. 1) | Basic skills | Reading | Locates pertinent information in service manuals and troubleshooting guides; applies information to job performance |
| | Thinking skills | Problem solving | Identifies possible reasons for problem |
| | Information | Acquisition and evaluation | Acquires information from manuals and guides |
| Inspect, test, and service an antilock brake system (J.S. 1) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all appropriate information |
| | Thinking skills | Reasoning | Applies rules and principles to a new situation |

## Related Academic and Workplace Skills

| Task | Skill Group | Sub Skill | Description |
|---|---|---|---|
| **Unit 3-A: Antilock Brake Systems (cont.)** | | | |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses equipment and materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Cleans, inspects, and services components as required |
| Troubleshoot antilock brake system problems (J.S. 2) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all appropriate information |
| | | Listening | Listens for content; receives and interprets oral messages |
| | | Speaking | Asks questions to obtain and clarify information; speaks in a clear, concise manner; pronounces words correctly |
| | Thinking skills | Problem solving | Identifies problems; draws conclusions from observations; determines repairs and/or replacements needed |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses tools and materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating test equipment |
| | | Maintenance and troubleshooting | Inspects, repairs, replaces, and adjusts faulty parts and/or connections |

## SECTION B: HYDRAULIC BRAKES

### Unit 1-B: Hydraulic Foundation Drum Brakes

| | | | |
|---|---|---|---|
| Remove, clean, inspect, and measure a brake drum (J.S. 1) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all appropriate information |
| | | Math | Uses measuring device |
| | Thinking skills | Problem solving | Draws conclusions from observations; determines repairs and/or replacements needed |

BEST COPY AVAILABLE

## Related Academic and Workplace Skills

### Unit 1-B: Hydraulic Foundation Drum Brakes (cont.)

| Task | Skill Group | Sub Skill | Description |
|---|---|---|---|
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Maintenance and troubleshooting | Cleans and inspects component |
| Remove, inspect, and replace brake shoes and related hardware (J.S. 2) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all appropriate information |
| | Thinking skills | Problem solving | Identifies problems; draws conclusions from observations |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Maintenance and troubleshooting | Inspects and evaluates component's condition |
| Replace brake drum and adjust brake clearance (J.S. 3) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all appropriate information |
| | | Math | Uses measuring device |
| | Thinking skills | Reasoning | Applies rules and principles to a new situation |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Cleans, replaces, and adjusts component as required |

## Related Academic and Workplace Skills

| Task | Skill Group | Sub Skill | Description |
|---|---|---|---|
| **Unit 2-B: Hydraulic Foundation Disc Brakes** | | | |
| Remove, clean, and inspect a caliper and pad assembly (J.S. 1) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all information |
| | Thinking skills | Problem solving | Identifies problems; draws conclusions from observations |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Inspects and evaluates component's condition |
| Inspect, measure, remove, and reinstall a rotor assembly (J.S. 2) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all information |
| | | Math | Uses measuring device |
| | Thinking skills | Problem solving | Evaluates conditions; determines needed repairs and adjustments |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Inspects, cleans, and reinstalls components as required |
| Reinstall caliper and pad assembly and check brake operation (J.S. 3) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all information |
| | Thinking skills | Reasoning | Applies rules and principles to a new situation |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Inspects, cleans, and reinstalls components as required |

BEST COPY AVAILABLE

## Related Academic and Workplace Skills

| Task | Skill Group | Sub Skill | Description |
|---|---|---|---|
| **Unit 3-B: Hydraulic System** | | | |
| Interpret hydraulic system diagrams (A.S. 1) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | Thinking skills | Reasoning | Applies rules and principles to a new situation |
| Interpret brake light system circuit diagrams (A.S. 2) | Basic skills | Reading | Follows written directions; interprets drawings to obtain factual information |
| | Thinking skills | Reasoning | Applies rules and principles to a new situation |
| Test hydraulic system and inspect for leaks; determine needed repairs (J.S. 1) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all information |
| | Thinking skills | Problem solving | Identifies problems; draws conclusions from observations; determines needed repairs |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Maintenance and troubleshooting | Tests and inspects system for leaks |
| Bleed and/or flush the hydraulic brake system (J.S. 2) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all information |
| | Thinking skills | Reasoning | Applies rules and principles to a new situation |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Services system |
| Remove, inspect, and repair or replace the hydraulic brake valve (J.S. 3) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all information |
| | Thinking skills | Problem solving | Identifies problems; draws conclusions from observation |
| | Personal management skills | Responsibility | Follows shop safety rules |

## Related Academic and Workplace Skills

### Unit 3-B: Hydraulic System (cont.)

| Task | Skill Group | Sub Skill | Description |
|---|---|---|---|
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Inspects, repairs, or replaces component/fluid as required |
| Remove, inspect, and repair or replace the master cylinder (J.S. 4) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all information |
| | Thinking skills | Problem solving | Identifies problems; draws conclusions from observations |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Inspects, repairs, or replaces component/fluid as required |
| Create flare and double flare fittings (J.S. 5) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all appropriate information |
| | Thinking skills | Reasoning | Applies rules and principles to a new situation |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| Remove and repair or replace the wheel cylinder (J.S. 6) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all information |
| | Thinking skills | Problem solving | Identifies problems; draws conclusions from observations; determines repairs and/or replacements needed |
| | Personal management skills | Responsibility | Follows shop safety rules |

## Related Academic and Workplace Skills

| Task | Skill Group | Sub Skill | Description |
|---|---|---|---|
| **Unit 3-B: Hydraulic System (cont.)** | | | |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Inspects, repairs, or replaces component/fluid as required |
| Check and adjust the parking brake (J.S. 7) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all information |
| | Thinking skills | Reasoning | Applies rules and principles to a new situation |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Checks and adjusts component as required |
| Check operation of brake light switch; adjust or replace as needed (J.S. 8) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all information |
| | Thinking skills | Problem solving | Evaluates conditions; determines needed repairs and adjustments |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Checks, repairs, or replaces component as required |

## Unit 4-B: Power Assist Units and Related Components

| Task | Skill Group | Sub Skill | Description |
|---|---|---|---|
| Inspect and test the power assist system and emergency brake back-up system; determine needed repairs (J.S. 1) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all information |
| | Thinking skills | Problem solving | Evaluates conditions; determines needed repairs and adjustments |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Checks, inspects system |
| Remove, inspect, and repair or replace the power assist unit (J.S. 2) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all information |
| | Thinking skills | Problem solving | Identifies problems; determines needed repairs and adjustments |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Inspects, repairs, or replaces component/fluid as required |
| Check operation of brake failure lights and braking warning devices; repair or replace as needed (J.S. 3) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual and/or operator's manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all information |
| | Thinking skills | Problem solving | Identifies problems; determines needed repairs |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Checks, repairs, or replaces parts as required |

BEST COPY AVAILABLE

## Related Academic and Workplace Skills

| Task | Skill Group | Sub Skill | Description |
|---|---|---|---|
| **SECTION C: AIR BRAKES** | | | |
| **Unit 1-C: Air Foundation Brakes** | | | |
| Inspect, service, and adjust slack adjuster on front axle (J.S. 1) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all information |
| | Thinking skills | Problem solving | Identifies problems; draws conclusions from observations; determines needed repairs and adjustments |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Inspects, services, and adjusts components as required |
| Inspect, test, service, and replace service brake chamber (J.S. 2) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all information |
| | Thinking skills | Problem solving | Identifies problems; draws conclusions from observations; determines needed repairs |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Inspects, tests, services, and repairs components as required |
| Remove, inspect, and replace brake shoes, drum, and hardware for s-cam drum foundation brakes (J.S. 3) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all information |
| | Thinking skills | Problem solving | Identifies problems; draws conclusions from observations; determines needed repairs and adjustments |
| | Personal management skills | Responsibility | Follows shop safety rules |

## Related Academic and Workplace Skills

### Unit 1-C: Air Foundation Brakes (cont.)

| Task | Skill Group | Sub Skill | Description |
|---|---|---|---|
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Inspects, replaces, and adjusts components as required |
| Remove, inspect, and replace brake shoes, drum, and hardware for wedge-type drum foundation brakes (J.S. 4) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all appropriate information |
| | Thinking skills | Problem solving | Identifies problems; draws conclusions from observations; determines needed repairs and adjustments |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Inspects, replaces, and adjusts components as required |
| Inspect, clean, and measure brake calipers, pads, and rotors; replace pads if needed (J.S. 5) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all appropriate information |
| | | Math | Uses measuring device |
| | Thinking skills | Problem solving | Identifies problems; draws conclusions from observations; determines needed repairs and adjustments |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Inspects, cleans, adjusts, and replaces components as required |

BEST COPY AVAILABLE

## Related Academic and Workplace Skills

### Unit 2-C: Air Supply System

| Task | Skill Group | Sub Skill | Description |
|---|---|---|---|
| Identify and connect components in an air supply system (A.S. 1) | Basic skills | Reading | Follows written directions |
| | Thinking skills | Reasoning | Sees relationship between two or more ideas, objects, or situations |
| | | Seeing things in the mind's eye | Visualizes a system's operation |
| Service the reservoir and check valve function, build-up time, and cut-out pressure (J.S. 1) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all information |
| | Thinking skills | Problem solving | Identifies problems; draws conclusions from observations; determines needed repairs and adjustments |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Services, checks, and adjusts components as required |
| Inspect and service belt-driven compressor and associated lines (J.S. 2) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all information |
| | Thinking skills | Problem solving | Identifies problems; draws conclusions from observations; determines needed repairs and adjustments |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Inspects, services, and adjusts components as required |
| Inspect, service, and time gear-driven compressor, valves, and associated lines (J.S. 3) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all information |
| | Thinking skills | Problem solving | Identifies problems; draws conclusions from observations; determines needed repairs and adjustments |

## Related Academic and Workplace Skills

### Unit 2-C: Air Supply System (cont.)

| Task | Skill Group | Sub Skill | Description |
|---|---|---|---|
|  | Personal management skills | Responsibility | Follows shop safety rules |
|  | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
|  | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
|  |  | Maintenance and troubleshooting | Inspects, services, and times components as required |
| Inspect and service air dryer system; repair or replace as needed (J.S. 4) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
|  |  | Writing | Completes job ticket neatly with all information |
|  | Thinking skills | Problem solving | Identifies problems; draws conclusions from observations; determines needed repairs and adjustments |
|  | Personal management skills | Responsibility | Follows shop safety rules |
|  | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
|  | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
|  |  | Maintenance and troubleshooting | Inspects, services, and repairs or replaces components as required |

### Unit 3-C: Air Service Circuits

| Task | Skill Group | Sub Skill | Description |
|---|---|---|---|
| Identify and connect components in the air service circuits (A.S. 1) | Basic skills | Reading | Follows written directions |
|  | Thinking skills | Reasoning | Sees relationships between two or more ideas, objects, or situations |
|  |  | Seeing things in the mind's eye | Visualizes a system's operation |
| Inspect and test brake application (foot) valve, fittings, and mounts; adjust or replace as needed (J.S. 1) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
|  |  | Writing | Completes job ticket neatly with all information |
|  | Thinking skills | Problem solving | Identifies problems; draws conclusions from observations; determines needed repairs and adjustments |
|  | Personal management skills | Responsibility | Follows shop safety rules |
|  | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |

BEST COPY AVAILABLE

## Related Academic and Workplace Skills

| Task | Skill Group | Sub Skill | Description |
|---|---|---|---|
| **Unit 3-C: Air Service Circuits (cont.)** | | | |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Inspects, tests, adjusts, and repairs or replaces parts and components |
| Inspect and test stop light circuit switches, wiring, and connectors; repair or replace as needed (J.S. 2) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all information |
| | Thinking skills | Problem solving | Identifies problems; draws conclusions from observations; determines needed repairs and adjustments |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Inspects, tests, repairs or replaces parts |
| Inspect and test relay valve; replace as needed (J.S. 3) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all information |
| | Thinking skills | Problem solving | Identifies problems; draws conclusions from observations; determines needed repairs and adjustments |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Inspects, tests, and replaces parts as required |
| Inspect and test quick release valve; replace as needed (J.S. 4) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all information |
| | Thinking skills | Problem solving | Identifies problems; draws conclusions from observations; determines needed repairs and adjustments |

## Related Academic and Workplace Skills

| Task | Skill Group | Sub Skill | Description |
|---|---|---|---|
| **Unit 3-C: Air Service Circuits (cont.)** | | | |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Inspects, tests, and replaces parts as required |
| **Unit 4-C: Special Circuits** | | | |
| Identify and connect components in a truck brake system (A.S. 1) | Basic skills | Reading | Follows written directions |
| | | Reasoning | Sees relationship between two or more ideas |
| | Thinking skills | Seeing things in the mind's eye | Visualizes a system's operation |
| Identify and connect components in a tractor brake system (A.S. 2) | Basic skills | Reading | Follows written directions |
| | | Reasoning | Sees relationship between two or more ideas |
| | Thinking skills | Seeing things in the mind's eye | Visualizes a system's operation |
| Inspect and test parking brake hand (control) valve; replace as needed (J.S. 1) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all information |
| | Thinking skills | Problem solving | Identifies problems; draws conclusions from observations; determines needed repairs and adjustments |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Inspects, tests, and replaces components as needed |
| Inspect and test inversion valve; replace as needed (J.S. 2) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all information |

## Related Academic and Workplace Skills

| Task | Skill Group | Sub Skill | Description |
|---|---|---|---|
| **Unit 4-C: Special Circuits (cont.)** | | | |
| | Thinking skills | Problem solving | Identifies problems; draws conclusions from observations; determines needed repairs and adjustments |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Inspects, tests, and replaces components as required |
| Inspect and test anti-compounding circuit equipped with Quick Release (QR) 1-C; replace as needed (J.S. 3) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all information |
| | Thinking skills | Problem solving | Identifies problems; draws conclusions from observations; determines needed repairs |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Inspects, tests, and replaces components as required |
| Inspect and test trailer air supply valve; replace as needed (J.S. 4) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all information |
| | Thinking skills | Problem solving | Identifies problems; draws conclusions from observations; determines needed repairs and adjustments |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Inspects, tests, and replaces components as required |

## Related Academic and Workplace Skills

| Task | Skill Group | Sub Skill | Description |
|---|---|---|---|
| **Unit 4-C: Special Circuits (cont.)** | | | |
| Inspect and test trailer brake control valve (hand valve); replace as needed (J.S. 5) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all information |
| | Thinking skills | Problem solving | Identifies problems; draws conclusions from observations; determines needed repairs and adjustments |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Inspects, tests, and replaces components as required |
| Inspect and test tractor protection valve; replace as needed (J.S. 6) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all information |
| | Thinking skills | Problem solving | Identifies problems; draws conclusions from observations; determines needed repairs and adjustments |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Inspects, tests, and replaces components as required |
| Check operation of parking brake; remove, inspect, and replace parking brake (spring brake) chamber as needed (J.S. 7) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all information |
| | | Math | Uses measuring device |
| | Thinking skills | Problem solving | Identifies problems; draws conclusions from observations; determines needed repairs and adjustments |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Removes, inspects, and replaces components as required |

## Related Academic and Workplace Skills

| Task | Skill Group | Sub Skill | Description |
|---|---|---|---|
| **Unit 5-C: Trailer Air Brake Systems** | | | |
| Identify and connect components of a trailer full function air brake system (A.S. 1) | Basic skills | Reading | Follows written directions |
| | Thinking skills | Reasoning | Sees relationship between two or more ideas, objects, or situations |
| | | Seeing things in the mind's eye | Visualizes a system's operation |
| Inspect and test tractor trailer gladhands; repair or replace as needed (J.S. 1) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all information |
| | Thinking skills | Problem solving | Identifies problems; draws conclusions from observations; determines needed repairs and adjustments |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Inspects, tests, and repairs or replaces components as required |
| Inspect and test trailer brake full function valve; replace as needed (J.S. 2) | Basic skills | Reading | Follows written directions; comprehends written information and applies it to a task; uses service manual to obtain procedure information |
| | | Writing | Completes job ticket neatly with all information |
| | Thinking skills | Problem solving | Identifies problems; draws conclusions from observations; determines needed repairs and adjustments |
| | Personal management skills | Responsibility | Follows shop safety rules |
| | Resources | Materials and facilities | Uses materials correctly; keeps work area clean |
| | Technology | Application | Demonstrates the proper procedure for setting up and operating equipment |
| | | Maintenance and troubleshooting | Inspects, tests, and replaces components as required |

## Tools, Equipment, and Materials List

- Air pressure test gauge
- Axle nut set
- Belt tension gauge
- Brake adjusting tool
- Brake bleeder kit
- Brake cylinder hone
- Brake resetting gauge
- Brake spring tool
- Brake washing equipment
- Circuit tester
- Cleaning supplies
- Container for brake fluid
- Dial indicator
- Drain pan
- Electronjc test equipment (scan tools, diagnostic data link, computer, connecting cables, etc.)
- Equipment to bleed hydraulic system
- Flare nuts
- Flashlight
- Glass container (small)
- High pressure washer
- High temperature waterproof grease
- Hydraulic floor jack
- Jack
- Jack stand
- Lubricant
- Measuring caliper tool
- Metallic-based, temperature resistant antiseize compound
- Operator's manual
- Power assist (booster) unit on hydraulic brake system
- Replacement brake fluid (appropriate for system)
- Replacement parts
- Service manuals (as appropriate)
- Snap ring plier set
- Soap solution
- Steel brake tubing
- Stop watch
- Straight edge
- Technician's common hand tools
- Test gauges and fittings
- Test light
- Torque wrench
- Tubing tool set
- Vehicles with various brake systems
- Vise
- Volt-ohmmeter
- Wet type brake parts cleaner
- Wheel assembly
- Wheel bearing and seal removal/installation kit
- Wheel chocks
- Wheel dolly
- Wire brush

# *Diesel Technology: Brakes*

## References

*The Air Brake Book*, 5th revised ed. Radnor, PA: Commercial Carrier Journal.

*Air Brake Handbook*. Elyria, OH: AlliedSignal Automotive, Truck Brake Systems Company, 1995.

*Air Brake System*. Allentown, PA: Mack Trucks, 1986.

*Air Disc Brakes, Maintenance Manual No. 4M.* Troy, MI: Rockwell International, 1992.

*Anti-lock Brake Systems for Trucks, Tractors and Buses, Maintenance Manual No. 28*. Troy, MI: Rockwell International Corporation, 1994.

*Anti-Lock Brake Systems for Trailers and Dollies, Maintenance Manual No. 29*. Troy, MI: Rockwell International Corporation, 1994.

*Antilock: Understanding It, Driving With It.* Troy, MI: Rockwell International Corporation, 1995.

*Automatic Slack Adjuster, Maintenance Manual No. 4B.* Troy, MI: Rockwell International Corporation, 1993.

*Automatic Slack Adjuster Service Manual*. Kansas City, MO: Midland Brake, Inc., 1990.

*Brakes Specialist*. Stillwater, OK: Curriculum and Instructional Materials Center/Oklahoma Department of Vocational and Technical Education, 1993.

Byrnes, Mike and Associates. *Bumper to Bumper*. Phoenix, AZ: Barron's Educational Series, Inc., 1993.

*Cam Brakes, Maintenance Manual No. 4*. Troy, MI: Rockwell International, 1992.

*Commercial Driver's License (CDL) Driver's Manual, Version 2.0* AAMVA.

Cross, Rich. *ABS Round 2*. Radnor, PA: Commercial Carrier Journal, 1997. (Printed online at http://www.ccjmagazine.com)

*Drum Brake Service Manual*. Galesburg, MI: Eaton Corporation, Brake Division, 1982.

*Ford Medium Truck Hydraulic Brakes*. Detroit, MI: Ford Parts and Service Division, Training and Publications Department, 1987.

*Fundamentals of Service; Bearings and Seals*. Moline, IL: Deere & Company, 1992.

*Grey-Rock Heavy Duty Brake Service Manual*. Owosso, MI: Grey-Rock, 1983.

*Hazardous Waste Regulations Pertaining to the Disposal of Waste From Clayton Brake Washers Using the CareFree Disposal System*. Lakewood, NJ: Clayton Associates, Inc., 1994.

*Hydraulic Disc Brakes: Medium Duty Truck*. Warren, MI: General Motors Corporation, 1983.

*Hydro-Max Power Brake System*. Detroit, MI: Ford Parts and Service Division, Training and Publications Department, 1986.

*Introduction to Automotive Service*. Stillwater, OK: Curriculum and Instructional Materials Center/Oklahoma Department of Vocational and Technical Education, 1989.

## References

Joerschke, John D. and Lane C. Eichhorn. *Diesel Technology: Introduction*. Stillwater, OK: Multistate Academic and Vocational Curriculum Consortium (MAVCC), 1997.

Kellum, Mary. *Diesel Technology: Safety Skills*. Stillwater, OK: Multistate Academic and Vocational Curriculum Consortium (MAVCC), 1996.

Miller, Roger, et al. *Diesel Technology: Steering and Suspension*. Stillwater, OK: Multistate Academic and Vocational Curriculum Consortium (MAVCC), 1997.

Norman, Ian Andrew et al. *Heavy Duty Truck Systems, 2nd ed.* Albany, NY: Delmar Publishers, Inc., 1996.

*OSHA Compliance Encyclopedia*. 3 volumes. Madison, CT: Business and Legal Reports, Inc., 1994.

Schulz, Erich J. *Diesel Equipment I: Lubrication, Hydraulics, Brakes, Wheels, and Tires*. Lake Forest, IL: Glencoe Division of Macmillan/McGraw-Hill Publishing Company, 1991.

*Stopping the Big Rigs: Training Manual for Air Brake Systems*. Kansas City, MO: Midland-Grau Heavy Duty Systems, 1995.

*Task Team Training Manual for Air Brake Systems*, L20225. Kansas City, MO: Midland-Grau Heavy Duty Systems, 1993.

*Trailer Product Training*, L20023. Kansas City, MO: Midland-Grau Heavy Duty Systems, 1993.

*Workbook and Learning Aid for Air Brake Systems*. Kansas City, MO: Midland-Grau Heavy Duty Systems, 1991.

## *Diesel Technology: Brakes*

### NATEF Crosswalk

The following NATEF tasks (rev. 1998) are covered in this publication. The first column identifies the NATEF task by name and number. The second column identifies the exact location by unit number and assignment sheet or job sheet number in this MAVCC publication.

| **NATEF Tasks** | **MAVCC Tasks** |
|---|---|
| IV. BRAKES | |
| A. Air Brakes Diagnosis and Repair | |
| **1. Air Supply and Service Systems** | |
| IV. A. 1.1—Listen to and verify operator's complaint; review past maintenance documents; determine needed repairs. | Unit 1-A, Assignment Sheet 2—Identify features for assigned vehicle.<br>Unit 3-A, Job Sheet 2—Troubleshoot antilock brake system problems. |
| IV. A. 1.2—Diagnose poor stopping, air leaks, pulling, grabbing, or dragging problems caused by supply and service system malfunctions; determine needed repairs. | Unit 1-A, Assignment Sheet 1—Diagnose and determine possible causes of general brake problems.<br>Unit 3-A, Assignment Sheet 1, Diagnose and determine possible causes of ABS problems.<br>Unit 3-A, Job Sheet 2—Troubleshoot antilock brake system problems. |
| IV. A. 1.3—Check air system build-up time; determine needed repairs. | Unit 2-C, Job Sheet 1—Service the reservoir and check valve function, build-up time, and cut-out pressure. |
| IV. A. 1.4—Drain air reservoir tanks; check for oil, water, and foreign material; determine needed repairs. | Unit 2-C, Job Sheet 1—Service the reservoir and check valve function, build-up time, and cut-out pressure. |
| IV. A. 1.5—Inspect, adjust, and align compressor drive belts, pulleys, and tensioners; replace as needed. | Unit 2-C, Job Sheet 2—Inspect and service belt-driven compressor and associated lines. |
| IV. A. 1.6—Inspect and time compressor drive gear and coupling; replace as needed. | Unit 2-C, Job Sheet 3—Inspect, service, and time gear-driven compressor, valves, and associated lines. |
| IV. A. 1.7—Inspect air compressor, air cleaner/supply; inspect oil and water lines and fittings; repair or replace as needed. | Unit 2-C, Job Sheet 2—Inspect and service belt-driven compressor and associated lines.<br>Unit 2-C, Job Sheet 3—Inspect, service, and time gear-driven compressor, valves, and associated lines. |

| NATEF Tasks | MAVCC Tasks |
|---|---|
| IV. BRAKES (cont.) | |
| IV. A. 1.8—Inspect, test, and adjust system pressure controls; governor, unloader assembly valves, filters, lines, hoses, and fittings; replace as needed. | Unit 2-C, Job Sheet 3—Inspect, service, and time gear-driven compressor valves, and associated lines.<br>Unit 2-C, Job Sheet 4—Inspect and service air dryer system; repair or replace as needed |
| IV. A. 1.9—Inspect air system lines, hoses, fittings, and couplings; repair or replace as needed. | Unit 3-C, Job Sheet 1—Inspect and test brake application (foot) valve, fittings, and mounts; adjust or replace as needed.<br>Unit 4-C, Job Sheet 6—Inspect and test tractor protection valve; replace as needed. |
| IV. A. 1.10—Inspect, test, and clean air tank relief (safety) valves, one-way check valves, drain cocks, automatic drain valves, heaters, wiring, and connectors; replace as needed. | Unit 2-C, Job Sheet 1—Service the reservoir and check valve function, build-up time, and cut-out pressure. |
| IV. A. 1.11—Inspect and clean air drier systems, filters, valves, heaters, wiring, and connectors; repair or replace as needed. | Unit 2-C, Job Sheet 4—Inspect and service air dryer system; repair or replace as needed. |
| IV. A. 1.12—Inspect and test brake application (foot) valve, fittings, and mounts; adjust or replace as needed. | Unit 3-C, Job Sheet 1—Inspect and test brake application (foot) valve, fittings, and mounts; adjust or replace as needed. |
| IV. A. 1.13—Inspect, test, and clean two-way check valves; replace as needed. | Unit 3-C, Job Sheet 1—Inspect and test brake application (foot) valve, fittings, and mounts; adjust or replace as needed. |
| IV. A. 1.14—Inspect and test stop and parking brake lamp circuit switches, wiring, and connectors; repair or replace as needed. | Unit 3-C, Job Sheet 2—Inspect and test stop light circuit switches, wiring, and connectors; repair or replace as needed.<br>Unit 4-C, Job Sheet 7—Check operation of parking brake; remove, inspect, and replace parking brake (spring brake) chamber as needed. |
| IV. A. 1.15—Inspect and test hand brake (trailer) control valve, lines, fittings, and mountings; repair or replace as needed. | Unit 4-C, Job Sheet 5—Inspect and test trailer brake control valve (hand valve); replace as needed. |
| IV. A. 1.16—Inspect and test brake relay valve; replace as needed. | Unit 3-C, Job Sheet 3—Inspect and test relay valve; replace as needed. |
| IV. A. 1.17—Inspect and test quick release valves; replace as needed. | Unit 3-C, Job Sheet 4—Inspect and test quick release valve; replace as needed. |

## NATEF Crosswalk

| **NATEF Tasks** | **MAVCC Tasks** |
|---|---|
| IV. BRAKES (cont.) | |
| IV. A.1.17 (cont.) | Unit 4-C, Job Sheet 3—Inspect and test anti-compounding circuit equipped with Quick Release (QR)-1C; replace as needed. |
| IV. A. 1.18—Inspect and test front and rear axle limiting (proportioning) valves; replace as needed. | |
| IV. A. 1.19—Inspect and test tractor protection valve; replace as needed. | Unit 4-C, Job Sheet 6—Inspect and test tractor protection valve; replace as needed. |
| IV. A. 1.20—Inspect and test emergency (spring) brake control valve(s); replace as needed | Unit 4-C, Job Sheet 7—Check operation of parking brake; remove, inspect, and replace parking brake (spring brake) chamber as needed. |
| IV. A. 1.21—Inspect and test inversion valve; replace as needed. | Unit 4-C, Job Sheet 2—Inspect and test inversion valve; replace as needed. |
| IV. A. 1.22—Inspect and test low pressure warning devices, wiring, and connectors; replace as needed. | Unit 2-C, Job Sheet 1—Service the reservoir and check valve function, build-up time, and cut-out pressure. |
| IV. A. 1.23—Inspect and test air pressure gauges, lines, and fittings; replace as needed. | Unit 3-C, Job Sheet 1—Inspect and test brake application (foot) valve, fittings, and mounts; adjust or replace as needed. |
| **2. Mechanical/Foundation** | |
| IV. A. 2.1—Listen to and verify operator's complaint; review past maintenance documents; determine needed repairs. | Unit 1-A, Assignment Sheet 1—Diagnose and determine possible causes of general brake problems.<br>Unit 3-A, Assignment Sheet 1—Diagnose and determine possible causes of ABS problems. |
| IV. A. 2.2—Diagnose poor stopping, brake noise, pulling, grabbing, or dragging complaints caused by foundation brake, slack adjuster, and brake chamber problems; determine needed repairs. | Unit 1-A, Assignment Sheet 1—Diagnose and determine possible causes of general brake problems. |
| IV. A. 2.3—Inspect, test, adjust, and service brake chambers, diaphragm, clamp, spring, pushrod, clevis, and mounting brackets; repair or replace as needed. | Unit 1-C, Job Sheet 2—Inspect, test, service, and replace service brake chamber. |
| IV. A. 2.4—Inspect and service manual slack adjusters; adjust or replace as needed. | Unit 1-C, Job Sheet 1—Inspect, service, and adjust slack adjuster on front axle. |

| **NATEF Tasks** | **MAVCC Tasks** |
|---|---|
| IV. BRAKES (cont.) | |
| IV. A. 2.5—Inspect and service automatic slack adjusters; replace as needed. | Unit 1-C, Job Sheet 1—Inspect, service, and adjust slack adjuster on front axle. |
| IV. A. 2.6—Inspect cams, rollers, shafts, bushings, seals, spacers, and retainers, service or replace as needed. | Unit 1—C, Job Sheet 3—Remove, inspect, and replace brake shoes, drum, and hardware for s-cam drum foundation brakes. |
| IV. A. 2.7—Inspect brakes spider, shields, anchor pins, bushings, and springs, service or replace as needed. | Unit 1—C, Job Sheet 3—Remove, inspect, and replace brake shoes, drum, and hardware for s-cam drum foundation brakes. |
| IV. A. 2.8—Inspect wedge brake spider, manual and automatic adjuster plungers, housing, and wedge assembly; repair or replace as needed. | Unit 1—C, Job Sheet 4—Remove, inspect, and replace brake shoes, drum, and hardware for wedge-type drum foundation brakes. |
| IV. A. 2.9—Inspect, clean, and adjust air disc brake caliper assemblies; determine needed repairs. | Unit 1—C, Job Sheet 5—Inspect, clean, and measure brake calipers, pads, and rotors; replace pads if needed. |
| IV. A. 2.10—Inspect brake shoes or pads; replace as needed. | Unit 1—C, Job Sheet 3—Remove, inspect, and replace brake shoes, drum, and hardware for s-cam drum foundation brakes.<br>Unit 1—C, Job Sheet 4—Remove, inspect, and replace brake shoes, drum, and hardware for wedge-type drum foundation brakes.<br>Unit 1—C, Job Sheet 5—Inspect, clean, and measure brake calipers, pads, and rotors; replace pads if needed. |
| IV. A. 2.11—Inspect and measure brake drums or rotors; replace as needed. | Unit 1—C, Job Sheet 3—Remove, inspect, and replace brake shoes, drum, and hardware for s-cam drum foundation brakes.<br>Unit 1—C, Job Sheet 4—Remove, inspect, and replace brake shoes, drum, and hardware for wedge-type drum foundation brakes. |
| **3. Parking Brakes** | |
| IV. A. 3.1—Inspect drive line parking brake drums, rotors, bands, shoes, mounting hardware, and adjusters; adjust, repair, or replace as needed. | Unit 4-C, Job Sheet 7—Check operation of parking brake; remove, inspect, and replace parking brake (spring brake) chamber as needed. |
| IV. A. 3.2—Inspect drive line parking brake application system pedal, cables, linkage, levers, pivots, and springs; adjust, repair, or replace as needed. | Unit 4-C, Job Sheet 7—Check operation of parking brake; remove, inspect, and replace parking (spring brake) chamber as needed. |

| NATEF Tasks | MAVCC Tasks |
|---|---|
| IV. BRAKES (cont.) | |
| IV. A. 3.3—Check operation of parking (spring) brake chamber; determine needed repairs. | Unit 4-C, Job Sheet 7—Check operation of parking brake; remove, inspect, and replace parking (spring brake) chamber as needed. |
| IV. A. 3.4—Inspect and test parking (spring) brake check valves, lines, hoses, and fittings; replace as needed. | Unit 4-C, Job Sheet 7—Check operation of parking brake; remove, inspect, and replace parking (spring brake) chamber as needed. |
| IV. A. 3.5—Inspect and test parking (spring) brake application and release valve; replace as needed. | Unit 4-C, Job Sheet 7—Check operation of parking brake; remove, inspect, and replace parking (spring brake) chamber as needed. |
| IV. A. 3.6—Manually release and reset parking (spring) brakes in accordance with manufacturer's recommendations. | Unit 4-C, Job Sheet 7—Check operation of parking brake; remove, inspect, and replace parking (spring brake) chamber as needed. |
| **4. Anti-lock Brake Systems** | |
| IV. A. 4.1—Inspect, test, and service anti-lock brake system (ABS) electrical/electronic and mechanical components. | Unit 3-A, Job Sheet 1—Inspect, test, and service an antilock brake system. |
| IV. A. 4.2—Diagnose poor stopping, wheel lock-up, pulsation, and noise problems caused by the anti-lock brake system (ABS); determine needed repairs. | Unit 3-A, Assignment Sheet 1—Diagnose and determine possible causes of ABS problems.<br>Unit 3-A, Job Sheet 2—Troubleshoot anti-lock brake system problems. |
| IV. A. 4.3—Observe anti-lock brake system (ABS) warning lamp at start up; determine if further diagnosis is needed. | Unit 3-A, Job Sheet 1—Inspect, test, and service an antilock brake system.<br>Unit 3-A, Job Sheet 2—Troubleshoot anti-lock brake system problems. |
| IV. A. 4.4—Interface with vehicle's on-board computer; perform diagnostic procedure using recommended electronic diagnostic equipment and tools (to include PC based software, and/or data scan tools); determine needed repairs. | Unit 3-A, Assignment Sheet 1—Diagnose and determine possible causes of ABS problems.<br>Unit 3-A, Job Sheet 2—Troubleshoot anti-lock brake system problems. |
| IV. A. 4.5—Diagnose anti-lock brake system (ABS) electronic control(s) and components using self-diagnosis or recommended test equipment; determine needed repairs. | Unit 3-A, Assignment Sheet 1—Diagnose and determine possible causes of ABS problems.<br>Unit 3-A, Job Sheet 2—Troubleshoot anti-lock brake system problems. |
| IV. A. 4.6—Service, test, and adjust anti-lock brake system (ABS) speed sensors following manufacturer's recommended procedures. | Unit 3-A, Job Sheet 1—Inspect, test, and service an anti-lock brake system. |

| NATEF Tasks | MAVCC Tasks |
|---|---|
| IV. BRAKES (cont.) | |
| IV. A. 4.7—Inspect automatic traction control system; determine needed repairs. | |
| B. Hydraulic Brakes Diagnosis and Repair | |
| **1. Hydraulic System** | |
| IV. B. 1.1—Listen to and verify operator's complaint; review past maintenance documents; determine needed repairs. | Unit 1-A, Assignment Sheet 1—Diagnose and determine possible causes of general brake problems. |
| IV. B. 1.2—Diagnose poor stopping, pulling, or dragging problems caused by the hydraulic system; determine needed repairs. | Unit 1-A, Assignment Sheet 1—Diagnose and determine possible causes of general brake problems. |
| IV. B. 1.3—Test hydraulic system; inspect for leaks. | Unit 3-B, Job Sheet 1—Test hydraulic system and inspect for leaks; determine needed repairs. |
| IV. B. 1.4—Check and adjust brake pedal pushrod length. | Unit 3-B, Job Sheet 4—Remove, inspect, and repair or replace the master cylinder. |
| IV. B. 1.5—Inspect and test master cylinder; replace as needed. | Unit 3-B, Job Sheet 4—Remove, inspect, and repair or replace the master cylinder. |
| IV. B. 1.6—Inspect brake lines, flexible hoses, and fittings; replace as needed. | Unit 3-B, Job Sheet 1—Test hydraulic system and inspect for leaks; determine needed repairs.<br>Unit 3-B, Job Sheet 4—Remove, inspect, and repair or replace the master cylinder. |
| IV. B. 1.7—Inspect and test metering (hold-off) proportioning, and combination valves; replace as needed. | Unit 3-B, Job Sheet 3—Remove, inspect, and repair or replace the hydraulic brake valve. |
| IV. B. 1.8—Inspect and test brake pressure differential valve and warning lamp circuit switch, bulbs, wiring, and connectors; repair or replace as needed. | Unit 4-B, Job Sheet 3—Check operation of brake failure lights and braking warning devices; repair or replace as needed. |
| IV. B. 1.9—Inspect wheel cylinders; replace as needed. | Unit 3-B, Job Sheet 6—Remove and repair or replace the wheel cylinder |
| IV. B 1.10—Inspect disc brake caliper assemblies; replace as needed. | Unit 2-B, Job Sheet 1—Remove, clean, and inspect a caliper and pad assembly.<br>Unit 2-B, Job Sheet 3—Reinstall caliper and pad assembly and check brake operation |

## NATEF Crosswalk

| NATEF Tasks | MAVCC Tasks |
|---|---|
| IV. BRAKES (cont.) | |
| IV. B 1.11—Bleed and flush hydraulic system. | Unit 3-B, Job Sheet 2—Bleed and/or flush the hydraulic brake system. |
| **2. Mechanical/Foundation** | |
| IV. B. 2.1—Listen to and verify operator's complaint; review past maintenance documents; determine needed repairs. | Unit 1-A, Assignment Sheet 1—Diagnose and determine possible causes of general brake problems.<br>Unit 3-A, Assignment Sheet 1—Diagnose and determine possible causes of ABS problems. |
| IV. B. 2.2—Diagnose poor stopping, noise, pulling, grabbing, dragging, or pedal pulsation problems caused by drum and disc brake mechanical assembly; determine needed repairs. | Unit 1-A, Assignment Sheet 1—Diagnose and determine possible causes of general brake problems. |
| IV. B. 2.3—Inspect and measure brake drums or rotors; replace as needed. | Unit 1-B, Job Sheet 1—Remove, clean, inspect, and measure a brake drum. |
| IV. B. 2.4—Inspect drum brake shoes, mounting hardware, adjuster mechanisms, and backing plates; replace as needed. | Unit 1-B, Job Sheet 2—Remove, inspect, and replace brake shoes and related hardware. |
| IV. B. 2.5—Inspect disc brake pads and mounting hardware; replace as needed. | Unit 1-B, Job Sheet 2—Remove, inspect, and replace brake shoes and related hardware. |
| **3. Power Assist Units and Related Components** | |
| IV. B. 3.1—Listen to and verify operator's complaint; review past maintenance documents; determine needed repairs. | Unit 1-A, Assignment Sheet 1—Diagnose and determine possible causes of general brake problems.<br>Unit 3-A, Assignment Sheet 1—Diagnose and determine possible causes of ABS problems. |
| IV. B. 3.2—Diagnose poor stopping problems caused by power brake booster(s); determine needed repairs. | Unit 1-A, Assignment Sheet 1—Diagnose and determine possible causes of general brake problems.<br>Unit 4-B, Job Sheet 1—Inspect and test the power assist system and emergency back-up system; determine needed repairs. |
| IV. B. 3.3—Inspect and test power brake booster(s), hoses, and control valves; replace as needed. | Unit 4-B, Job Sheet 1—Inspect and test the power assist system and emergency back-up system; determine needed repairs. |

| NATEF Tasks | MAVCC Tasks |
|---|---|
| IV. BRAKES (cont.) | |
| IV. B. 3.4—Test and adjust brake stop lamp switch, bulbs, wiring, and connectors; repair or replace as needed.<br>IV. B. 3.5—Check emergency (stand-by) hydraulic boost system. | Unit 4-B, Job Sheet 1—Inspect and test the power assist system and emergency back-up system; determine needed repairs.<br>Unit 4-B, Job Sheet 1—Inspect and test the power assist system and emergency back-up system; determine needed repairs. |
| **4. Anti-lock Brake Systems** | |
| IV. B. 4.1—Inspect, test, and service anti-lock brake system (ABS), electrical/electronic, and mechanical components. | Unit 3-A, Job Sheet 1—Inspect, test, and service an antilock brake system. |
| IV. B. 4.2—Diagnose poor stopping, wheel lock-up, pulsation, and noise problems caused by the anti-lock brake system (ABS); determine needed repairs. | Unit 3-A, Assignment Sheet 1—Diagnose and determine possible causes of ABS problems.<br>Unit 3-A, Job Sheet 2—Troubleshoot anti-lock brake system problems. |
| IV. B. 4.3—Observe anti-lock brake system (ABS) warning lamp at start-up; determine if further diagnosis is needed. | Unit 3-A, Job Sheet 1—Inspect, test, and service an antilock brake system.<br>Unit 3-A, Job Sheet 2—Troubleshoot anti-lock brake system problems. |
| IV. B. 4.4—Interface with vehicle's on-board computers; perform diagnostic procedure using recommended electronic diagnostic equipment and tools (to include PC based software and/or data scan tools); determine needed repairs. | Unit 3-A, Assignment Sheet 1—Diagnose and determine possible causes of ABS problems.<br>Unit 3-A, Job Sheet 2--Troubleshoot anti-lock brake system problems. |
| IV. B. 4.5—Diagnose anti-lock brake system (ABS) electronic control(s) and components using self-diagnosis and/or recommended test equipment; determine needed repairs. | Unit 3-A, Assignment Sheet 1—Diagnose and determine possible causes of ABS problems.<br>Unit 3-A, Job Sheet 2—Troubleshoot anti-lock brake system problems. |
| IV. B. 4.6—Service, test, and adjust anti-lock brake system (ABS) speed sensors following manufacturer's recommended procedures. | Unit 3-A, Job Sheet 1—Inspect, test, and service an antilock brake system. |

# Introduction to Brakes
## Unit 1-A

### Unit Contents

**Teacher Components** **Teacher Page**

1. Suggested Activities

a. Instructional Plan .......... 1
b. Teaching Suggestions .......... 2
c. Resources Used in Developing This Unit .......... 3
d. Suggested Supplemental Resources .......... 4
e. Suggested Internet Sites .......... 6
f. Instructions for Evaluating Student Performance .......... 6

2. Transparency Masters

1—Operation of a Hydraulic Brake System .......... 7
2—Operation of an Air Brake System .......... 9

3. Written Test .......... 11

4. Answers to Written Test .......... 19

5. Unit Evaluation Form .......... 21

**Student Components** **Student Page**

DT:B

1. Objective Sheet .......... A-1

2. Information Sheet .......... A-3

3. Assignment Sheets

1—Diagnose and Determine Possible Causes of General Brake Problems .......... A-15
2—Identify Features for Assigned Vehicle .......... A-17

4. Job Sheets

1—Move Vehicle and Prepare for Service .......... A-19
2—Check Brake Fluid Level and Condition and Inspect for Leaks .......... A-21

# Introduction to Brakes
# Unit 1-A

## Suggested Activities

### Instructional Plan

### Preparation

1. Read the unit carefully and plan for instruction.
2. Review "Teaching Suggestions." Plan for classroom activities.
3. Plan for students with special needs.
4. Obtain videotapes, service manuals, and other resources to supplement instruction of this unit. See "Resources" for more information.
5. Make transparencies from the transparency masters included in this unit.
6. Develop teaching plan. Adjust for different learning styles.
7. Review "Instructions for Evaluating Student Performance."
8. Make copies of the Unit Evaluation Form, one for each student.

### Delivery and Application

9. Provide students with unit of instruction.
10. Discuss unit and specific objectives.
11. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
12. Discuss the assignment sheets. Review criteria for evaluation of these activities.
13. Discuss and demonstrate the job sheets. Make sure all required tools, equipment, and supplies are available. Review criteria for evaluation of this activity.

### Evaluation

14. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.
15. Make copies of the written test. Add or modify test items as needed.
16. Give written test.
17. Compile assignment sheet ratings, job sheet ratings, and written test scores on the Unit Evaluation Form. Add any additional assignments or supplemental activities that should be part of the unit evaluation.
18. Reteach and retest as required.

## Suggested Activities

### Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A Report for America 2000* and *Workplace Basics: The Skills Employers Want*. These have been adapted by MAVCC.

1. Discuss the basic principles of physics that apply to braking and brake systems. These are defined in objective 3.

    a. You can demonstrate the basic principles of energy, force, work, power, and momentum using simple technology experiments. Discuss these ideas and the availability of inexpensive experiments with a local high school science teacher or technology education teacher for resources and assistance.

    b. You can demonstrate gravity and friction by using a sheet of plywood or a wide board, various heights of blocks or cans (to incline the board), and toy trucks with semi-trailers. Show students the forces that act on a truck rolling down a hill. You can vary these forces by increasing/decreasing the weight of the truck and trailer, by raising/lowering the incline, and by increasing/reducing the friction of the board's surface using sandpaper or oil. Discuss how these factors impact on the braking of the truck.

    Summarize by explaining how the brake system is the vehicle's main mechanism for controlling these scientific principles. **(Basic Skills—Science; Thinking Skills—Reasoning; Technology—Application)**

2. Point out examples of the different types of brake systems. These are described in objective 4. Discuss their similarities and differences. **(Thinking Skills—Decision making)**

3. Demonstrate the operations of both hydraulic brake systems and air brake systems. You may want to use actual vehicles in the shop or mock-ups to better show the parts involved and the operation. Label the steps with the correct sequence numbers. Make sure students understand the overall operation of both systems. The specific parts and their functions will be covered in more detail in Sections B (hydraulic) and C (air). Discussions at this time should just cover the overall operation and the most basic parts. **(Systems—Interrelationships; Technology—Application)**

4. Discuss the basic differences and similarities between hydraulic and air brake systems. Then explain where and why the different systems are used in specific applications. For example, explain why air brakes are generally used for heavy-duty applications and hydraulic brakes are generally used for light/medium-duty applications. Also discuss the need for combining systems in some applications. **(Thinking Skills—Decision making)**

5. Show examples of DOT 3, 4, and 5 brake fluids. Also discuss their different applications. **(Thinking Skills—Decision making; Resources—Materials)**

6. Use damaged brake components to illustrate common problems that occur on brake systems and as a starting place for discussing failure analysis of brake systems. **(Thinking Skills—Problem solving; Resources—Material; Technology—Maintenance and troubleshooting)**

7. Conduct a field trip to a local brake repair facility (or general shop that is currently working on brake systems) so students can see failure analysis investigations being performed. If possible, have the owner, supervisor, or master technician discuss the most common problems that cause brake failures and what can be done to prevent failures. **(Basic Skills—Listening; Thinking Skills—Problem solving; Information—Acquisition; Technology—Troubleshooting)**

## Suggested Activities

8. Discuss the safety hazards associated with brake service discussed in objective 14. Personalize the information by relating any experiences you have had or seen that involved accidents or mishaps that occurred during brake service work. **(Personal Management Skills—Responsibility and organizational effectiveness [value of safety])**

9. Discuss with students the school policy on road tests and any special precautions, licenses, or safety testing that is required.

    a. If students will be driving or road testing vehicles, conduct individual safety checks where each student demonstrates his/her driving ability. Record all safety tests and place in each student's permanent file.

    b. Provide students with the necessary information for your state about obtaining a commercial driver's license if required for road testing. Make a photocopy of each student's commercial driver's license with the date issued and place in each student's permanent file.

    c. If school policy does not allow students to road test vehicles, discuss how you plan to modify the troubleshooting/failure analysis process.

    **(Personal Management Skills—Responsibility and organizational effectiveness [value of safety])**

10. Discuss the hazards of asbestos and non-asbestos dust associated with brake service. Demonstrate the OSHA-approved brake cleaning equipment available in your shop that is required for brake work. **(Personal Management Skills—Responsibility and organizational effectiveness [value of safety]; Technology—Application)**

11. Make a display of all special brake tools and equipment covered in objective 16 with names attached so students can practice identifying them. You may wish to then remove the labels and give students a hands-on practical test to identify the tools on display. This test/quiz may be conducted individually or as a class group or team activity. **(Information—Acquisition; Technology—Selection and application)**

12. Make sure that service manuals and troubleshooting guides are available for students to use in Assignment Sheet 1. You may need to explain or review how to correctly use these resources. **(Basic Skills—Reading; Resources—Material; Information—Acquisition and evaluation)**

## Resources Used in Developing This Unit

1. *The Air Brake Book*, 5th revised ed. Radnor, PA: Commercial Carrier Journal.
2. *Air Brake Handbook*. Elyria, OH: AlliedSignal Automotive, Truck Brake Systems Company, 1995.
3. *Brakes Specialist*. Stillwater, OK: Curriculum and Instructional Materials Center/Oklahoma Department of Vocational and Technical Education, 1993.
4. Byrnes, Mike and Associates. *Bumper to Bumper*. Phoenix, AZ: Barron's Educational Series, Inc., 1993.
5. *Commercial Driver's License (CDL) Driver's Manual*, Version 2.0. AAMVA.
6. *Ford Medium Truck Hydraulic Brakes*. Detroit, MI: Ford Parts and Service Division, Training and Publications Department, 1987.
7. *Grey-Rock Heavy Duty Brake Service Manual*. Owosso, MI: Grey-Rock, 1983.

## Suggested Activities

8. *Hazardous Waste Regulations Pertaining to the Disposal of Waste From Clayton Brake Washers Using the CareFree Disposal System.* Lakewood, NJ: Clayton Associates, Inc., 1994.

9. *Hydraulic Disc Brakes: Medium Duty Truck.* Warren, MI: General Motors Corporation, 1983.

10. Kellum, Mary. *Diesel Technology: Safety Skills.* Stillwater, OK: Multistate Academic and Vocational Curriculum Consortium (MAVCC), 1996.

11. Norman, Ian Andrew et al. *Heavy Duty Truck Systems*, 2nd ed. Albany, NY: Delmar Publishers, Inc., 1996.

12. *OSHA Compliance Encyclopedia.* 3 volumes. Madison, CT: Business and Legal Reports, Inc., 1994.

## Suggested Supplemental Resources

1. *Don't Blow It.* 16-minute videotape that deals with brake asbestos. Available from:

   Clayton Associates, Inc.
   P.O. Box 589
   Farmingdale, NJ 07727-0589
   1-800-248-8670

2. *Brake Maintenance and Overhaul* (AXSV-0007) 22-minute VHS videotape.

3. *Safe Downhill Braking* (BROV-0015) VHS videotape.

   2 and 3 are available from:
   Eaton Corporation
   Literature Distribution
   P.O. Box 717
   Mechanicsburg, PA 17055
   Fax 1-717-697-7092

4. *Stopping the Big Rigs*, Part # VL35 video. Presents overview of truck/tractor air brake system.

   Available from:

   Midland-Grau Heavy Duty Systems
   10930 N. Pomona Avenue
   Kansas City, MO 64153
   1-816-891-2470 or fax 816-891-9447

5. *Hydraulic Disc Brakes: Medium Duty Truck Manual*, (Item #P-9068). Introduction to General Motors hydraulic disc brakes. 72 pages.

6. *Drum Brakes Manual*, (Item # P-9075-1). Explains operation and repair of 1939–1985 General Motors models. 64 pages.

   5 and 6 are available from:

   Automotive Service Association
   P.O. Box 929
   Bedford, TX 76095-0929
   1-817-283-6205, 1-800-272-7467, or fax 1-817-685-0225

## Suggested Activities

7. *Air Brake System Service Manual*, 16.1.

8. *FDM700 Hydraulic System Service Manual*, 22-201.

   7 and 8 are available from your local Mack Truck service center or contact:

   Mack Trucks, Inc.
   2100 Mack Boulevard
   P.O. Box M
   Allentown, PA 18105-5000
   1-610-439-3011

9. *Hydraulics Explained: Principles and Fluids, Unit 1*, 18-minute video.

10. *Hydraulics Explained: Actuators, Unit 2*, 19-minute video.

11. *Hydraulics Explained: Controls, Unit 3*, 10-minute video.

12. *Hydraulics Explained: Pumps and Power Units*, Unit 4, 17-minute video.

    9–12 are available as 4 videos or 2CDs from:

    National Innovative Media Company (NIMCO)
    P.O. Box 9
    102 Hwy. 81 North
    Calhoun, KY 42327
    1-800-962-6662 or fax 1-502-273-5844

13. *Fundamentals of Air Brakes*, BW1559, VHS training video. Available from:

    AlliedSignal Truck Brake Systems Co.
    901 Cleveland Street
    P.O. Box 4016
    Elyria,OH 44036-2016
    1-216-329-9000

14. *B400T Inspection (Heavy Duty Trucks)* videotape, (order # 3536-T) Covers use of B400T brake tester to diagnose brake condition. Available from:

    Hunter Engineering Company
    Service Center 2531 Metro Boulevard
    Maryland Heights, MO 63043-2411

## Suggested Activities

### Suggested Internet Sites

1. Allied Signal, Inc.
   http://www.alliedsignal.com
2. Brake Manufacturers Council
   http://www.brakecouncil.org
3. Carlisle Motion Control Industries, Inc.
   http://www.carlislemotion.com
4. Commercial Carrier Journal
   http://www.ccjmagazine.com
5. Dana Corporation
   http://www.dana.com
6. U.S. Department of Transportation
   http://www.dot.gov
7. Eaton Corporation
   http://www.eaton.com
8. Euclid Industries, Inc.
   http://www.euclidind.com
9. Freightliner Corporation
   http://www.freightliner.com
10. Gunite Corporation
    http://www.gunite.com
11. Haldex Group
    http://www.haldex.com
12. Lucas Varity Heavy Vehicle Braking Systems
    http://www.lvhvbs-dayton.com
13. Mack Trucks, Inc.
    http://www.macktrucks.com
14. Meritor Automotive
    http://www.meritorauto.com
    (for Rockwell Automotive)
15. Haldex Midland Services
    http://www.midland.com
16. Navistar International Transp. Co.
    http://www.navistar.com
17. Paccar Inc.
    http://www.paccar.com (for Peterbilt and Kenworth)
18. Trucklink
    http://www.trucklink.com
19. Wabco Automotive Products Group
    http://www.wabco-auto.com

### Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

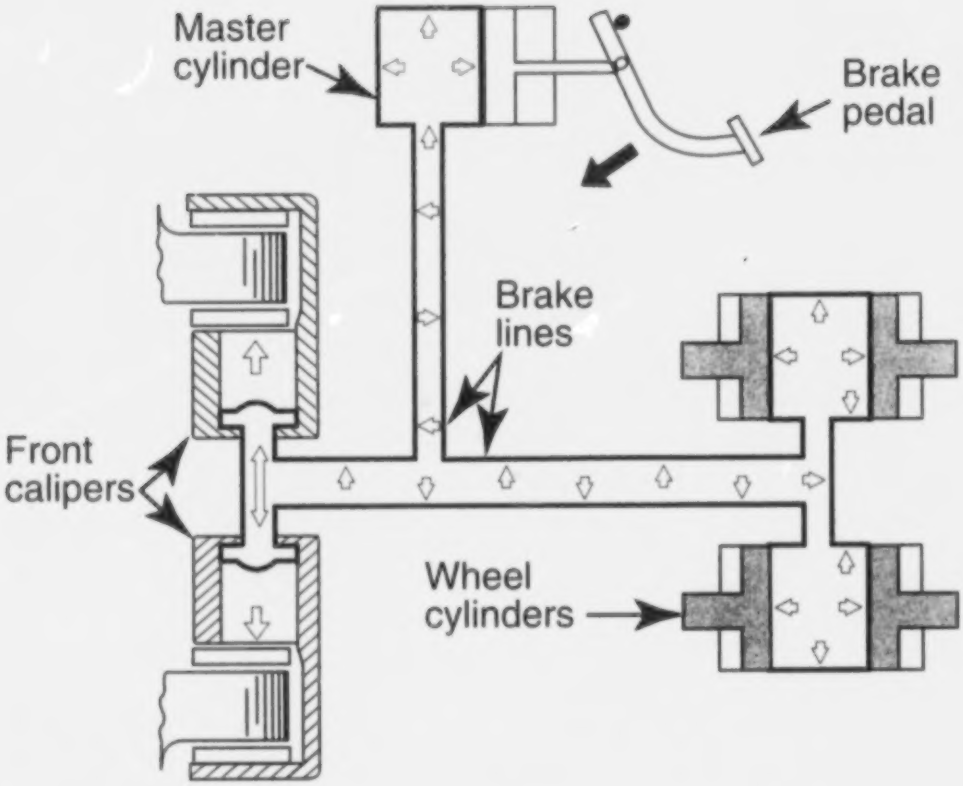
4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

Option B

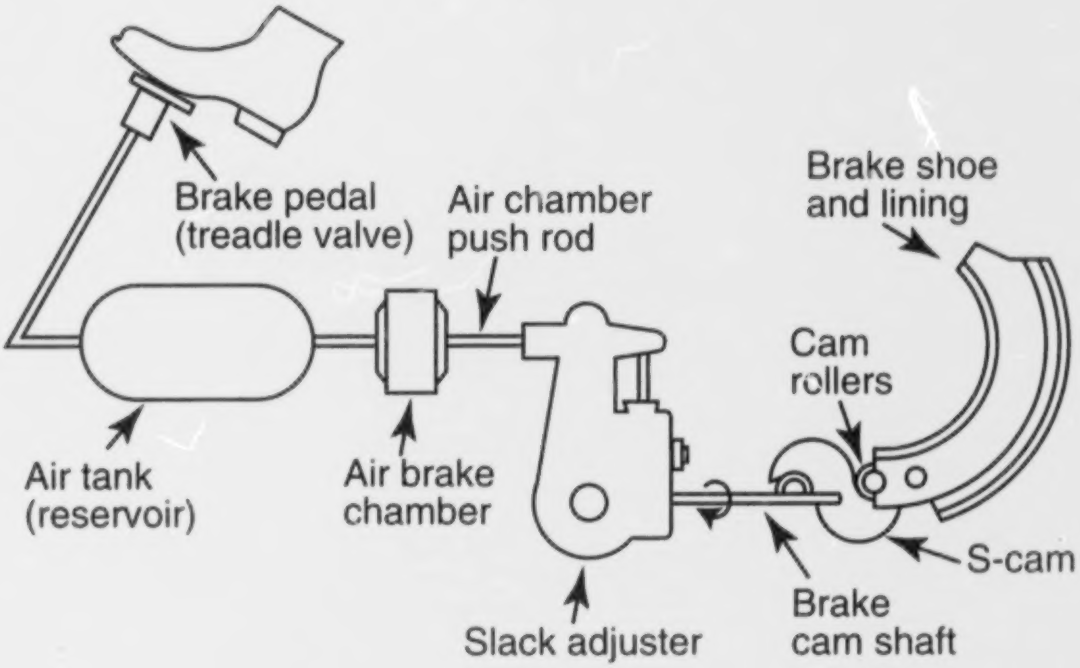
Yes—Can perform job with no additional training.

No—Is unable to perform job satisfactorily.

# Operation of a Hydraulic Brake System


Master cylinder
Brake pedal
Brake lines
Front calipers
Wheel cylinders

# Operation of an Air Brake System


Brake pedal (treadle valve)
Air chamber push rod
Brake shoe and lining
Cam rollers
Air tank (reservoir)
Air brake chamber
S-cam
Brake cam shaft
Slack adjuster

Courtesy of Haldex Midland Services

# Introduction to Brakes
## Unit 1-A

### Written Test

Name ______________________ Date ____________ Score ____________

1. Match the terms on the right with the correct definitions.

_______ a. Relating to the use of air to transmit force

_______ b. Symptom that helps identify product, operation, or maintenance problem

_______ c. Specific condition that started the problem

_______ d. Inability to perform the desired function; usually occurs prematurely or unexpectedly

_______ e. Substance used to transmit force in hydraulic brake systems

_______ f. To weaken or destroy gradually by chemical means

_______ g. Time elapsed between depression of brake pedal and engagement of the linings with the drums

_______ h. Scientific study of matter and energy and how they interact

_______ i. Relating to the use of fluid to transmit force

_______ j. Process of removing all old fluid from hydraulic system and replacing it with new fluid

_______ k. Class of magnesium-silicate minerals that occur in fibrous form

_______ l. Process by which air and contaminants are removed from hydraulic system

_______ m. Permanent, untreatable lung scarring caused by exposure to asbestos; causes shortness of breath

_______ n. Distance a vehicle travels from the time force is applied to brake control until vehicle reaches a full stop

1. Application time
2. Asbestos
3. Asbestosis
4. Bleeding
5. Brake fluid
6. Contaminants
7. Corrode
8. Defect
9. Failure
10. Flushing
11. Foreign material
12. Hydraulic
13. Indicator
14. Physics
15. Pneumatic
16. Release time
17. Root cause
18. Stopping distance
19. Wear

## Written Test

2. State two purposes of the brake system.

a. ______________________________

b. ______________________________

3. Match scientific principles that affect brake systems on the right with their correct definitions.

_______ a. Force that one mass exerts on another; most familiar source is the Earth

_______ b. Rate at which work is done or energy is transmitted; measured in horsepower, torque, or watts

_______ c. Movement as a result of applied force

_______ d. Change in velocity

_______ e. State of an object changing its location in space

_______ f. Rate of motion

_______ g. Property of a moving body that determines the amount of force and the length of time required to bring it to rest

_______ h. Resistance to movement between two objects in contact with each other

_______ i. Applied energy that causes change in the motion or shape of an object

_______ j. Ability to do work; types include mechanical, electrical, light, heat, nuclear

1. Acceleration/deceleration
2. Energy
3. Force
4. Friction
5. Gravity
6. Momentum
7. Motion
8. Power
9. Velocity or speed
10. Work

4. Match the types of brake systems on the right with their correct descriptions.

_______ a. Uses gears, levers, cables, and similar devices to transfer force through the brake system

_______ b. Uses electromagnetic force to transfer force through the brake system

_______ c. Uses brake fluid to transfer force through the brake system

_______ d. Uses air to transfer force through the brake system

_______ e. Uses electrical and hydraulic components to eliminate engine's power stroke so that engine power is retarded

1. Air
2. Electrical
3. Engine
4. Hydraulic
5. Mechanical

## Written Test

5. Complete statements concerning the operation of a hydraulic brake system by filling in the blanks with the correct answers.

   a. Brake fluid is stored in a reservoir called a ______________________ and in brake lines connecting it to the wheel cylinders.

   b. Depressing the brake pedal forces a ______________ to move one or more pistons in the master cylinder to seal the fluid between the master cylinder and the wheel cylinders.

   c. Additional pressure on the brake pedal pushes the pistons in the wheel cylinders, which then causes the ________________ to press against the wheels. This increased friction causes the wheels to slow and eventually stop if pressure continues to be applied.

   d. When the brake pedal is released, springs return the master cylinder pistons to their open position so that the ____________________ is no longer under pressure.

   e. With the pressure released, the pistons in the wheel cylinders move back into their cylinders with the force returning to ___________ pressure.

6. Arrange in order the steps in the operation of an air brake system by placing the correct sequence numbers (1–5) in the appropriate blanks.

   _____ a. When the brake pedal is released, air is exhausted from the air brake chambers and springs return the shoes to their released position.

   _____ b. Movement of the piston actuates a lever (slack adjuster), which rotates the s-cam.

   _____ c. Depressing the brake pedal releases pressurized air from the tanks, which is then applied to the piston in the air brake chamber.

   _____ d. An air compressor pressurizes air and stores it in air tanks.

   _____ e. This causes the brake shoes to make contact with the brake drum. Friction between the shoes and the drum causes the wheels to slow and eventually stop if pressure continues to be applied.

7. Compare hydraulic and air brake systems by circling the correct answers.

   a. Application time is faster for **(air, hydraulic)** brakes.

   b. Release time is faster for **(air, hydraulic)** brakes.

   c. Pressure leaks in **(air, hydraulic)** brakes will not lead to loss of braking.

   d. **(Air, Hydraulic)** brakes require moderate maintenance.

   e. **(Air, Hydraulic)** brake systems are difficult to expand.

## Written Test

8. Match types of brake fluid on the right with their correct descriptions.

_______ a. Glycol-based fluid

_______ b. Synthetic, silicon-based fluid

_______ c. Highest boiling point of the three types described

_______ d. Lowest boiling point of the three types described

_______ e. Purple tinted

_______ f. Clear or amber tinted

_______ g. Does not absorb moisture when exposed to air

1. DOT 1
2. DOT 2
3. DOT 3
4. DOT 4
5. DOT 5

9. Distinguish between correct and incorrect guidelines for handling and storing brake fluid by placing a "C" for correct and an "I" for incorrect in the appropriate blanks.

_______ a. Change the brake fluid at each minor repair.

_______ b. Take care not to spill fluid on any chrome or painted surface.

_______ c. Always keep fluid clean; do not allow any foreign material or petroleum product to get into the fluid.

_______ d. Always replace the brake fluid when you suspect moisture contamination in the hydraulic brake lines.

_______ e. Use the largest possible can of brake fluid to fill the master cylinder.

_______ f. Never recap the fluid container after use.

_______ g. Store brake fluid away from heat or flame.

10. Distinguish between the purposes of troubleshooting and failure analysis by placing an "X" next to the description of troubleshooting.

_______ a. To find and correct the problem

_______ b. To find the root cause of the problem and to correct both the cause and the problem

11. Arrange in order the steps in failure analysis by placing the correct sequence numbers (1–10) in the appropriate blanks.

_______ a. Communicate with your supervisor/instructor and/or owner/operator/customer about your conclusion.

_______ b. Perform detailed examination, if necessary and recommended by manufacturer, to narrow down the root cause.

## Written Test

__3__ c. Refer to the manufacturer's troubleshooting guide to list the probable root causes for the problem(s) you have identified.

_____ d. Follow up with customer to make sure problem is corrected and customer is satisfied.

_____ e. Inspect the vehicle to gather and organize facts. This is the preliminary examination.

_____ f. Operate the vehicle (if possible) to learn more about the vehicle and to identify the problem.

_____ g. Test and operate vehicle to make sure problem is corrected. If not, go back to list of possible causes and decide on the next most likely cause. Repeat remaining steps until problem is solved.

_____ h. Obtain information about the circumstances surrounding the failure.

_____ i. Make repairs/replacements as directed and approved.

__6__ j. Select most probable root cause based on total evidence.

12. Describe three of the signs of brake failure.

    a. ______________________________

    ______________________________

    b. ______________________________

    ______________________________

    c. ______________________________

    ______________________________

13. Discuss two of the most common causes of brake failure.

    a. ______________________________

    b. ______________________________

14. Distinguish between correct and incorrect safety procedures to follow when working on brakes by circling "Do" or "Do Not" as appropriate.

    a. **(Do, Do not)** follow all safety precautions identified by the manufacturer.

    b. **(Do, Do not)** block the truck-tractor and trailer wheels prior to working on the vehicle.

    c. **(Do, Do not)** rely on the brake system to hold the vehicle.

    d. **(Do, Do not)** wear personal protective equipment as required.

    e. **(Do, Do not)** use great care around both hydraulic and air brake systems.

## Written Test

f. **(Do, Do not)** road test vehicle if the brake warning light is lit.

g. **(Do, Do not)** place vehicle in gear before starting it.

h. **(Do, Do not)** release the pressure from pressurized lines quickly before working on the vehicle.

i. **(Do, Do not)** follow the manufacturer's special disassembly procedures for pressurized components and systems.

j. **(Do, Do not)** use properly lifting techniques and lifting devices when moving or holding heavy components.

15. Complete statements concerning an overview of asbestos and safety guidelines to follow when working around asbestos by filling in the blanks with the correct answers.

a. Because some brake ____________________ contain asbestos, it is important that you know the potential hazards of asbestos and the precautions to take to protect yourself.

b. Exposure to airborne asbestos dust can cause serious and possibly fatal diseases, especially asbestosis and ________________ cancer.

c. The most important things to remember are:

1) Avoid ________________ asbestos (or non-asbestos) dust when working on brakes.

2) Avoid ________________ any dust accidentally created.

d. Always use OSHA-approved brake cleaning equipment. In the diesel technology shop, there are two preferred methods that should be used for all brake and clutch inspection, disassembly, repair, and assembly:

1) Negative pressure enclosure vacuum system with HEPA (high efficiency particulate air) filters; also used with air-purifying respirators

2) ______________________________________________________

e. Never use ____________________ air or dry brushing to clean brake parts or assemblies.

f. Read the ________________________________________ for any products containing asbestos, as required by OSHA, and follow any additional safety precautions they recommend.

g. When cleaning the brake work area, use a damp mop on the floor and a damp rag on all countertops to remove any remaining dust. This helps prevent asbestos fibers from becoming ____________________.

h. Do not ________________________ brake linings. This is specialty work that requires additional precautions because contact with fiber dust is higher during these operations.

i. Wash your ____________________ before eating, drinking, or smoking.

## Written Test

16. Match specialty brake tools and equipment on the right with their correct functions.

_______ a. Used as a driver to install wheel seal into hub

_______ b. Used to remove and install retaining spring clips

_______ c. Used to adjust clearance between brake drum and brake shoe

_______ d. Used to form ends of tubing to allow installation of connector fittings

_______ e. Used to drive bearing race into wheel hub

_______ f. Used to resurface wheel cylinders to remove corrosion and slight pitting

_______ g. Used to determine proper clearance between brake lining and drum

_______ h. Used to compress disc caliper pistons

_______ i. Used as pressure tank to automatically bleed hydraulic system

_______ j. Used to lift, move, or hold heavy wheel components

_______ k. Used to drive wear ring on axle

_______ l. Used to measure thickness of rotor

_______ m. Used to force grease into wheel bearings

1. Asbestos removal system
2. Bearing packer
3. Bearing race installer
4. Brake adjusting tool
5. Brake bleeder
6. Brake rotor gauge
7. Brake shoe retaining spring tool
8. Brake spring tool
9. Disc caliper tool
10. Drum brake gauge
11. Metering valve tool
12. Pressure gauge
13. Seal installer
14. Seal ring installer
15. Tube flaring set
16. Tubing bender
17. Wheel cylinder hone
18. Wheel dolly

Permission to duplicate this test is granted.

# Introduction to Brakes
# Unit 1-A

## Answers to Written Test

1.
   - a. 15
   - b. 13
   - c. 17
   - d. 9
   - e. 5
   - f. 7
   - g. 1
   - h. 14
   - i. 12
   - j. 10
   - k. 2
   - l. 4
   - m. 3
   - n. 18

2. Any two of the following:
   - a. To slow the vehicle
   - b. To stop the vehicle
   - c. To hold the vehicle when stopped
   - d. To provide an emergency means of stopping the vehicle

3.
   - a. 5
   - b. 8
   - c. 10
   - d. 1
   - e. 7
   - f. 9
   - g. 6
   - h. 4
   - i. 3
   - j. 2

4.
   - a. 5
   - b. 2
   - c. 4
   - d. 1
   - e. 3

5.
   - a Master cylinder
   - b. Pushrod
   - c. Brake shoes or pads
   - d. Brake fluid
   - e. Zero

6.
   - a. 5
   - b. 3
   - c. 2
   - d. 1
   - e. 4

7.
   - a. Hydraulic
   - b. Hydraulic
   - c. Air
   - d. Air
   - e. Hydraulic

8.
   - a. 3 or 4
   - b. 5
   - c. 5
   - d. 3
   - e. 5
   - f. 3 or 4
   - g. 5

9.
   - a. I
   - b. C
   - c. C
   - d. C
   - e. I
   - f. I
   - g. C

## Answers to Written Test

10. a

11.
   a. 7
   b. 5
   c. 3
   d. 10
   e. 4
   f. 2
   g. 9
   h. 1
   i. 8
   j. 6

12. Any three of the following:
   a. **No braking**—When the driver actuates the brakes, there is no evidence of the vehicle slowing or stopping
   b. **Improper brake pedal feel**—When the driver presses the brake pedal, its movement or response is not normal
   c. **Improper vehicle motion**—When the brakes are applied, the vehicle vibrates excessively, pulls to one side, lunges, or otherwise handles erratically
   d. **Audible signs**—When the brakes are applied, unexpected noises occur or expected noises do not occur
   e. **Visible signs**—Cracks, leaks, smoke, or other indications that can be seen by the operator or service technician
   f. **Instrument indicators**—Warning lights and displays in the vehicle that alert the driver to malfunctions

13. Any two of the following:
   a. Defective or incorrect parts installed
   b. Improper service of brake system
   c. Improper service of related systems
   d. Overheating
   e. For hydraulic brakes—Improper or inadequate brake fluid
   f. For air brakes—Contaminants in air system or air leaks

14.
   a. Do
   b. Do
   c. Do not
   d. Do
   e. Do
   f. Do not
   g. Do not
   h. Do not
   i. Do
   j. Do

15.
   a. Linings
   b. Lung
   c. 1) Creating
      2) Breathing
   d. Low pressure/wet cleaning brake cleaning equipment
   e. Compressed
   f. Material safety data sheets (MSDS)
   g. Airborne
   h. Grind or machine (either answer)
   i. Hands

16.
   a. 13
   b. 7
   c. 4
   d. 15
   e. 3
   f. 17
   g. 10
   h. 9
   i. 5
   j. 18
   k. 14
   l. 6
   m. 2

# Introduction to Brakes
## Unit 1-A

### Unit Evaluation Form

Student Name ______________________ Unit Rating __________

Assignment Sheet 1—Diagnose and Determine Possible Causes of General Brake Problems Rating ______

Comments: ______________________

______________________

Assignment Sheet 2—Identify Features for Assigned Vehicle Rating ______

Comments: ______________________

______________________

Job Sheet 1—Move Vehicle and Prepare for Service Rating ______

Comments: ______________________

______________________

Job Sheet 2—Check Brake Fluid Level and Condition and Inspect for Leaks Rating ______

Comments: ______________________

______________________

**Written Test Scores**

Pretest __________ Posttest __________ Other __________

Other ______________________

______________________

**Teacher Signature** ______________________ Date __________

**Student Signature** ______________________ Date __________

Permission to duplicate this form is granted.

# Wheel Bearings and Seals
# Unit 2-A

## Unit Contents

**Teacher Components** **Teacher Page**

1. Suggested Activities
   - a. Instructional Plan .......... 1
   - b. Teaching Suggestions .......... 2
   - c. Resources Used in Developing This Unit .......... 3
   - d. Suggested Supplemental Resources .......... 3
   - e. Instructions for Evaluating Student Performance .......... 5
2. Transparency Masters
   - 1—Parts of a Wheel Bearing .......... 7
   - 2—Axle Assembly .......... 9
   - 3—Full-Floating Drive Axle .......... 11
   - 4—Common Wheel Bearing Defects .......... 13
3. Written Test .......... 15
4. Answers to Written Test .......... 21
5. Unit Evaluation Form .......... 25

**Student Components** **Student Page**

DT:B

1. Objective Sheet .......... A-25
2. Information Sheet .......... A-27
3. Assignment Sheets
   - 1—Evaluate Worn and Damaged Wheel Bearings and Seals .......... A-37
   - 2—Select Appropriate Replacement Wheel Bearings and Seals .......... A-41
4. Job Sheet
   - 1—Remove, Inspect, Clean, Replace, and Adjust Wheel Bearings and Seals .......... A-43

# Wheel Bearings and Seals
## Unit 2-A

### Suggested Activities

**Instructional Plan**

**Preparation**

1. Read the unit carefully and plan for instruction.
2. Review "Teaching Suggestions." Plan for classroom activities.
3. Plan for students with special needs.
4. Obtain videotapes, service manuals, and other resources to supplement instruction of this unit. See "Resources" for more information.
5. Make transparencies from the transparency masters included in this unit.
6. Develop teaching plan. Adjust for different learning styles.
7. Review "Instructions for Evaluating Student Performance."
8. Make copies of the Unit Evaluation Form, one for each student.

**Delivery and Application**

9. Provide students with unit of instruction.
10. Discuss unit and specific objectives.
11. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
12. Discuss the assignment sheets. Review criteria for evaluation of these activities.
13. Discuss and demonstrate the job sheet. Make sure all required tools, equipment, and supplies are available. Review criteria for evaluation of this activity.

**Evaluation**

14. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.
15. Make copies of the written test. Add or modify test items as needed.
16. Give written test.
17. Compile assignment sheet ratings, job sheet ratings, and written test scores on the Unit Evaluation Form. Add any additional assignments or supplemental activities that should be part of the unit evaluation.
18. Reteach and retest as required.

## Suggested Activities

### Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A Report for America 2000* and *Workplace Basics: The Skills Employers Want*. These have been adapted by MAVCC.

1. Disassemble or cut apart a wheel bearing, and have students identify the main parts. **(Thinking Skills—Knowing how to learn and reasoning)**

2. Make a display of the most common wheel bearings and seals used on the vehicles/equipment that students will be servicing in the shop. Point out the main identifying features and their most common applications. **(Thinking Skills—Knowing how to learn)**

3. Make another display of worn and damaged (defective) wheel bearings and seals. Have students identify the different types of defects. This practice will help them prepare for Assignment Sheet 1. **(Thinking Skills—Problem solving and reasoning: Resources—Material; Technology—Troubleshooting)**

4. Discuss the most common problems that you have encountered with wheel bearings and seals. Refer to Information Sheet Objectives 6 and 13 for the most common causes of failures. Describe what may be required to solve each problem. **(Thinking Skills—Problem solving; Technology—Troubleshooting)**

5. Discuss safety precautions to follow when working on wheel and hub assemblies. Tell about any accidents that you have seen or been involved in as they relate to wheel assemblies, including the bearings and seals. Also discuss what students should do in case of an accident. **(Personal Management Skill—Responsibility and organizational effectiveness [value of safety])**

6. Demonstrate the correct procedures for servicing and adjusting wheel bearings and installing wheel seals. Show and demonstrate the special tools and techniques required. Point out the most common mistakes of previous students. **(Technology—Selection, application, maintenance, and troubleshooting)**

7. Assignment Sheets 1 and 2 require prior set-up by the instructor. You will need to provide the following:

    a. Assignment Sheet 1—Provide six worn and/or damaged (defective) wheel bearings and seals that students can evaluate. There need to be three wheel bearings and three wheel seals. All should be labeled or tagged so students can correctly describe them in the assignment.

    b. Assignment Sheet 2—Assign a certain vehicle to each student so s/he can identify the appropriate replacement wheel bearings and seals. Also make sure that the appropriate resource materials (service manuals, troubleshooting guides, parts lists, or ordering lists) are available to students to look up the necessary information for both front and rear wheel bearings and seals.

## Suggested Activities

### Resources Used in Developing This Unit

1. *Fundamentals of Service: Bearings and Seals.* Moline, IL: Deere & Company, 1992.
2. *Introduction to Automotive Service.* Stillwater, OK: Curriculum and Instructional Materials Center/Oklahoma Department of Vocational and Technical Education, 1989.
3. Joerschke, John D. and Lane C. Eichhorn. *Diesel Technology: Introduction.* Stillwater, OK: Multistate Academic and Vocational Curriculum Consortium (MAVCC), 1997.
4. Miller, Roger, et al. *Diesel Technology: Steering and Suspension.* Stillwater, OK: Multistate Academic and Vocational Curriculum Consortium (MAVCC), 1997.

### Suggested Supplemental Resources

1. *How to Install Seals Instruction Manual* (#457809)
2. *CR Bearings Videotape* (#457296)

   1 and 2 are available from:

   CR Services
   735 tollgate Road
   Elgin, IL 60123
   1-800-882-0008 or 1-847-742-7840

3. *Wheel Bearing Adjustment Procedure Wall Chart* (T0400). 24″ x 36″. Describes consistent method of achieving a verifiable wheel bearing end play of 0.001″ to 0.005″. Procedure applies to steer, drive, and trailer-axle assemblies using conventional double-nut or single-nut systems.
4. *Wheel Bearing Adjustment Procedure Pocket Reference* (T0420). Same information as wall chart above in a pocket-sized format.

   3 and 4 are available from:

   American Trucking Associations
   Customer Services Dept.
   2200 Mill Road
   Alexandria, VA 22314-4677
   1-800-ATA-LINE

5. *Computer Wheel Balancers*, 20-minute videotape. Available from your local Snap-On Tool Representative or call 1-800-756-3344 to order.
6. *Wheel Bearing Adjustment Procedure*, 16-minute videotape (T-89158V). Available from:

   Rockwell International Corporation
   2135 West Maple Road
   Troy, MI 48084
   1-800-535-5560

78

## Suggested Activities

7. *Wheel Bearings Service Manual* (15-701). Available from your local Mack Truck service center or contact:

   Mack Trucks, Inc.
   2100 Mack Blvd.
   P.O. Box M
   Allentown, PA 18105-5000
   1-610-439-3011

8. Wall charts—color

   a. *Proper Installation of National Oil Bath Seals*

   b. *Proper Installation of Wheel Bearings*

   c. *Anti-Friction Bearing Distress Analysis*

      8a–c wall charts are available from your local Federal-Mogul dealer or contact the national headquarters:

      Federal-Mogul Corporation
      26555 Northwestern
      Southfield, MI 48034
      1-810-354-7700

9. *Midland Barrier Oil Seal*, Part # VL4 video. Available from:

   Midland-Grau Heavy Duty Systems
   10930 N. Pomona Avenue
   Kansas City, MO 64153
   1-816-891-2470 or fax 816-891-9447

# Suggested Activities

## Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

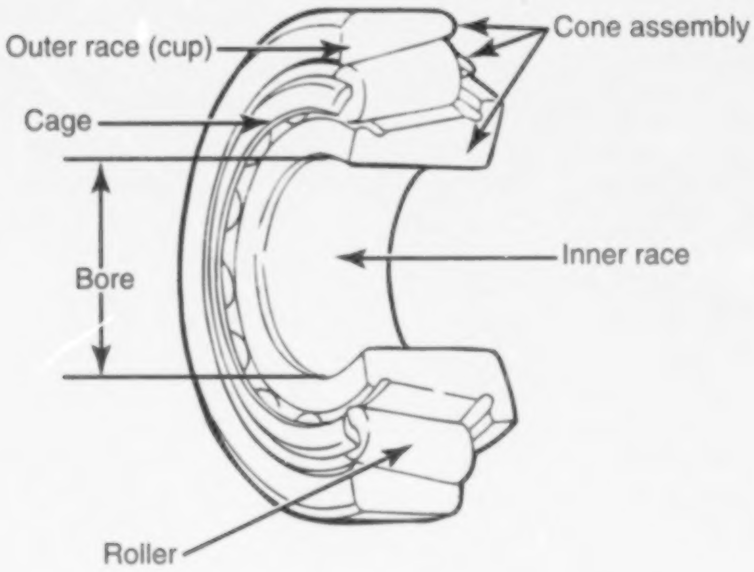
4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

Option B

Yes—Can perform job with no additional training.

No—Is unable to perform job satisfactorily.

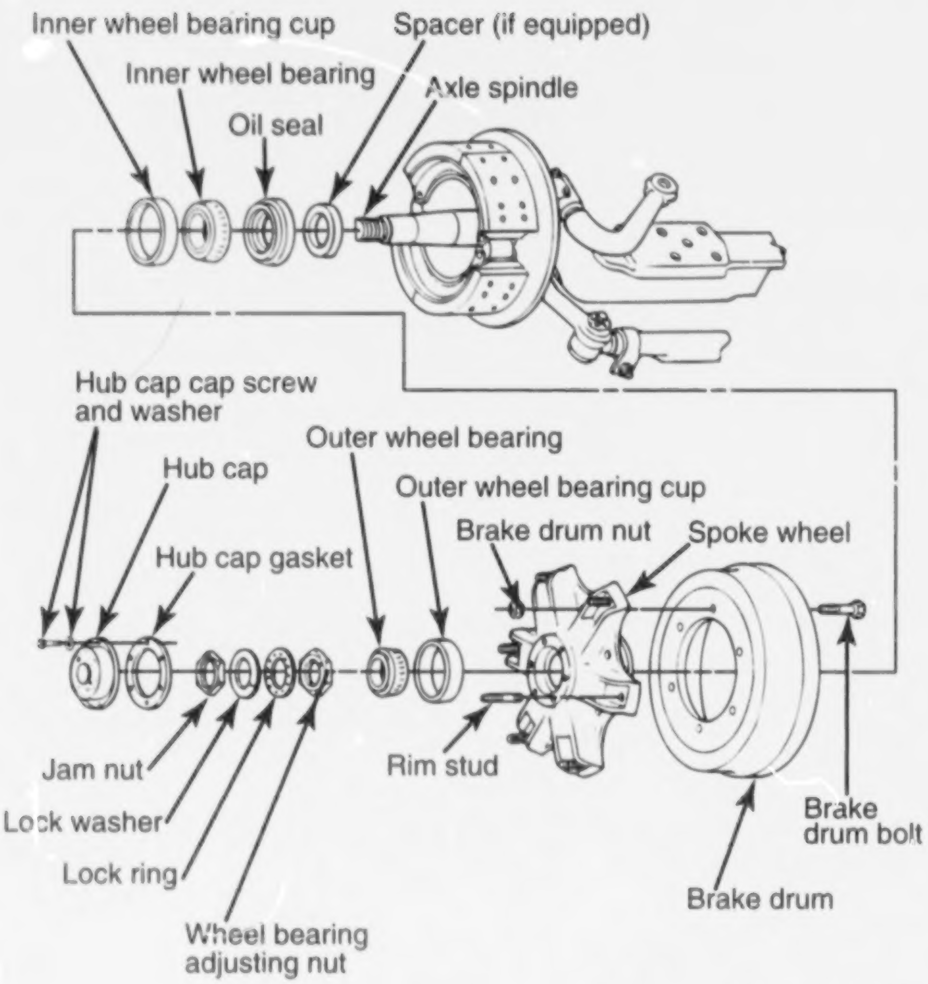
# Parts of a Wheel Bearing



Outer race (cup)
Cone assembly
Cage
Bore
Inner race
Roller

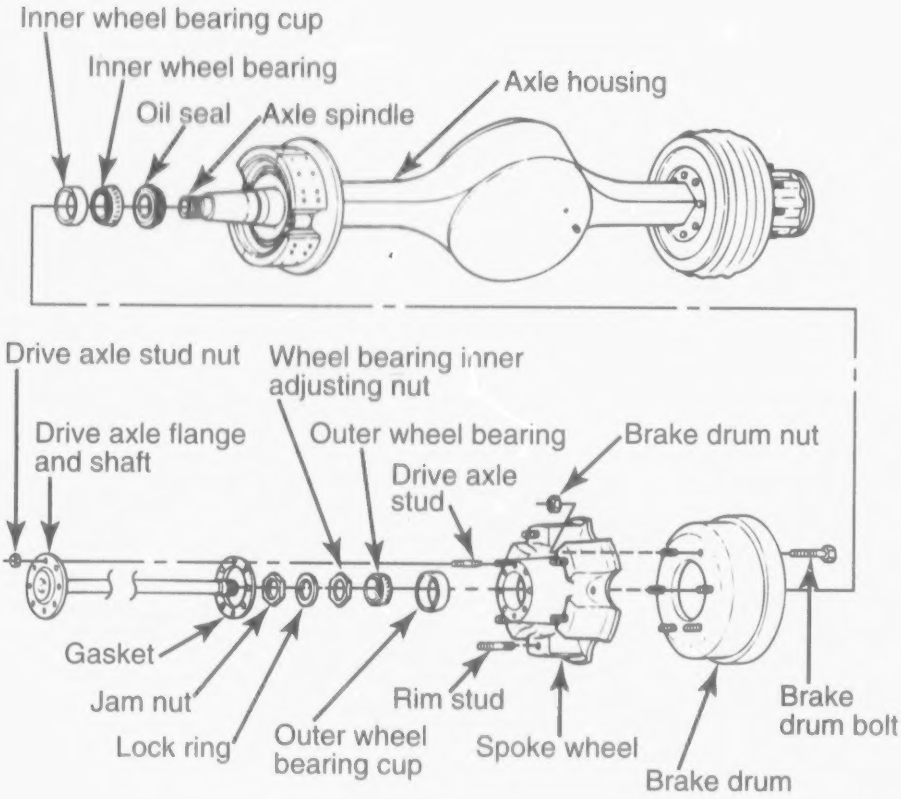
TM 1

# Axle Assembly


Inner wheel bearing cup
Spacer (if equipped)
Inner wheel bearing
Axle spindle
Oil seal
Hub cap cap screw and washer
Outer wheel bearing
Hub cap
Outer wheel bearing cup
Brake drum nut
Spoke wheel
Hub cap gasket
Jam nut
Rim stud
Lock washer
Brake drum bolt
Lock ring
Brake drum
Wheel bearing adjusting nut

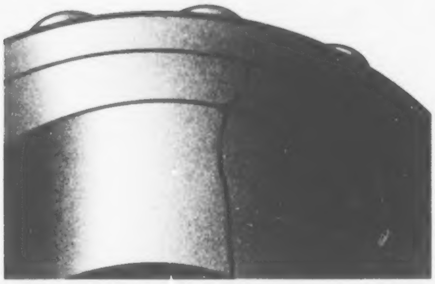
Courtesy of Freightliner Corporation

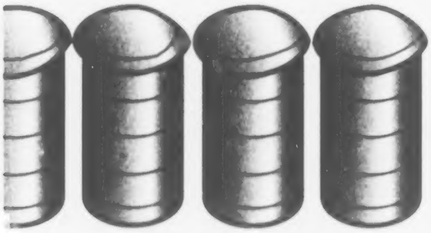
# Full-Floating Drive Axle

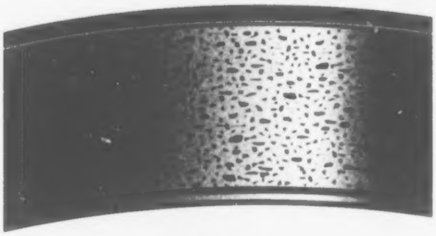

Inner wheel bearing cup
Inner wheel bearing
Oil seal
Axle spindle
Axle housing
Drive axle stud nut
Wheel bearing inner adjusting nut
Drive axle flange and shaft
Outer wheel bearing
Brake drum nut
Drive axle stud
Gasket
Jam nut
Lock ring
Outer wheel bearing cup
Rim stud
Spoke wheel
Brake drum
Brake drum bolt

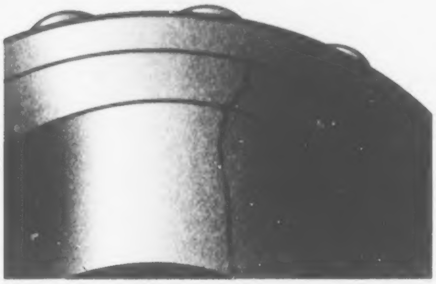
Courtesy of Freightliner Corporation

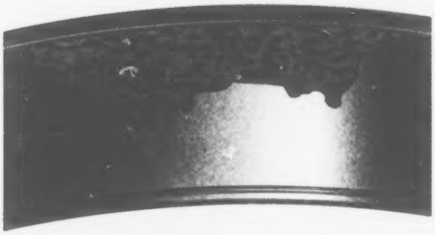
# Common Wheel Bearing Defects

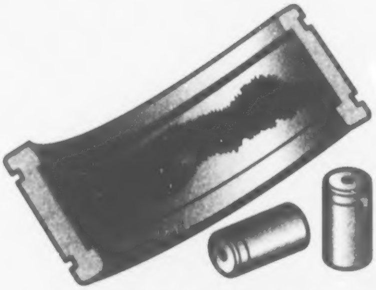

Mechanical Damage


Abrasive Wear


Pitting


Brinelling


Spalling


Discoloration

# Wheel Bearings and Seals
# Unit 2-A

## Written Test

Name ______________________ Date ______________ Score ______________

1. Match the terms on the right with the correct definitions.

_______ a. Part that helps spread the forces of a load to reduce the friction and wear of a moving part

_______ b. Tracks or channels in which something rolls or slides

_______ c. Amount of lateral movement of the hub along the spindle due to clearance in the bearings

_______ d. Bearing used to distribute the load of a vehicle on its axles

_______ e. Material used to form a leakproof connection between moving or fixed parts

_______ f. That part of a shaft, axle, or spindle that turns in a bearing

_______ g. Act of forcing grease into wheel bearings

_______ h. Adjustment of bearings so that there is a slight load on them to ensure proper internal alignment and limiting of end play

_______ i. Axle that contains a knuckle which allows the vehicle to be turned

_______ j. In excess of designed load

_______ k. Structural member attached to the suspension which connects the wheels and allows them to turn through a series of bearings

_______ l. Tight fit between mating parts; must be "pressed" into place

1. Axle (straight axle)
2. Bearing
3. Drive axle
4. End play
5. Full-floating drive axle
6. Journal
7. Overload
8. Packing
9. Preload
10. Press fit
11. Races
12. Seal
13. Spindle
14. Steering axle
15. Wheel and hub assembly
16. Wheel bearing

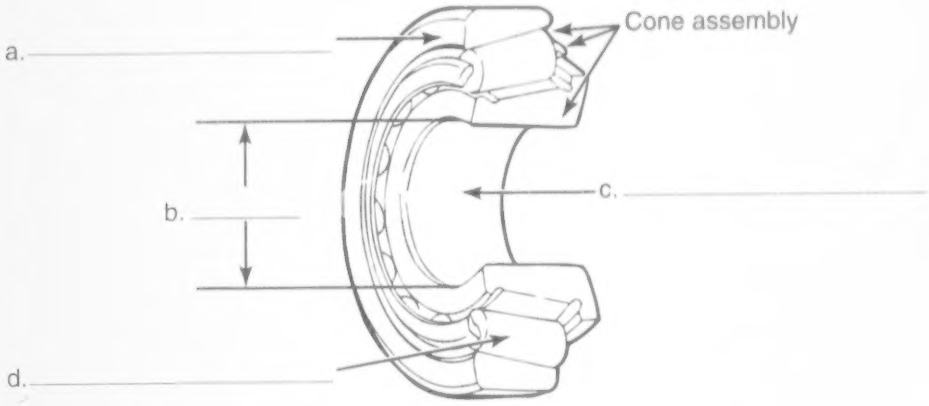
2. List two purposes of wheel bearings.

a. ______________________________________________

b. ______________________________________________

## Written Test

3. Label the parts of the wheel bearing below. Write your answers on the blanks provided.



a. ____________________

b. ________

c. ____________________

d. ____________________

4. Match the parts of wheel and hub assemblies listed below with their illustrations and illustration numbers. Place your answers (numbers) in the blanks provided.

_______ a. Axle spindle

_______ b. Brake drum

_______ c. Hub cap

_______ d. Hub cap gasket

_______ e. Inner wheel bearing

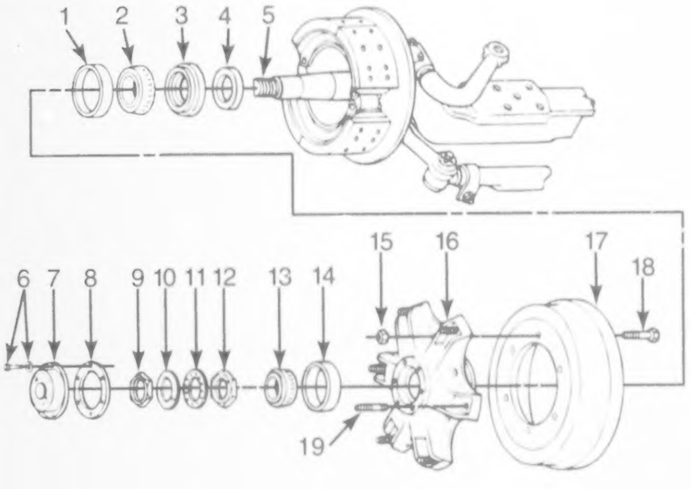
_______ f. Inner wheel bearing cup

_______ g. Oil seal

_______ h. Outer wheel bearing

_______ i. Outer wheel bearing cup

_______ j. Wheel bearing adjusting nut



Courtesy of Freightliner Corporation

## Written Test

5. Complete the following chart of common wheel bearing defects by filling in the blanks with the correct answers.

| Name of Defect | Description | Possible Cause | Remedy |
|---|---|---|---|
| **Mechanical damage** | Deforming or breaking of the bearing assembly | a. | Replace bearing |
| **Abrasive wear** | Wear on the rollers or races | b. | Replace if wear is excessive or simply clean and repack if wear is minor |
| **Pitting** | c. | Contamination with large particles | Clean and repack or replace if bearings are rough or noisy |
| d. | Surface indentations in the raceway that parallel the rollers | Excessive loading or vibration while the bearing is not rotating or improper installation | Generally replace bearing |
| **Spalling** | e. | Metal fatigue or poor quality bearings | Replace bearings |
| **Discoloration** | Discoloration ranging from faint yellow to dark blue | f. | Replace bearings |

6. List four reasons for bearing failure.

   a. ______________________________

   b. ______________________________

   c. ______________________________

   d. ______________________________

7. Describe three results of each of the following wheel bearing problems.

   a. Loose or worn wheel bearings can cause

      1) ______________________________

      2) ______________________________

      3) ______________________________

b. Overtightened wheel bearings can cause

1) ________________________________

2) ________________________________

3) ________________________________

8. List two types of wheel bearing lubricants.

a. ________________________________

b. ________________________________

9. Complete the following statements concerning guidelines for servicing wheel bearings by circling the correct answers.

a. Follow the **(bearing, vehicle)** manufacturer's recommendations for the selection and installation of wheel bearings.

b. Follow the **(bearing, vehicle)** manufacturer's instructions for the selection and installation of lubricant.

c. Every wheel has **(two, four)** sets of bearings. Be sure you don't install these backwards.

d. Use only an approved **(detergent, solvent)** to clean bearings.

e. If compressed air is used to clean bearings, use only **(low, high)** pressure.

f. Observe **(asbestos exposure, bloodborne pathogen)** precautions because brake linings and other components may be contaminated.

g. If the condition of a bearing, seal, or other component is in doubt, **(reuse, replace)** it.

10. Distinguish between correct and incorrect guidelines for adjusting wheel bearings by placing:

C—next to correct guidelines
I—next to incorrect guidelines

_______ a. Follow the vehicle service manual procedure to adjust bearings.

_______ b. Adjust all bearings with preload.

_______ c. Use a dial indicator to adjust end play.

_______ d. While adjusting bearings, make sure that brakes drag on drum or rotor.

_______ e. Rotate wheel in only one direction while torquing the adjusting nut.

11. List two purposes of wheel seals.

a. ________________________________

b. ________________________________

## Written Test

12. List one type of wheel seal for each category.

    a. One-piece—__________________________________________

    b. Multipiece—__________________________________________

13. Describe two causes of sealing failure.

    a. __________________________________________

    __________________________________________

    b. __________________________________________

    __________________________________________

14. Complete the following statements concerning guidelines for installing wheel seals by filling in the blanks with the correct answers.

    a. Take care when prying out the old seal not to ____________________ the housing.

    b. Inspect the bore and shaft for ____________________ that could cut the new seal.

    c. Check shaft and bore dimensions to make sure they match the ____________________ specifications.

    d. Excessively worn or grooved shafts may be fitted with ____________________ to create a new seal running surface.

    e. Never ____________________ old or damaged seals.

    f. Make sure the new seal faces in the correct direction; usually the lip ______________ the lubricant or fluid to be retained.

Permission to duplicate this test is granted.

# Wheel Bearings and Seals
# Unit 2-A

## Answers to Written Test

1. a. 2
   b. 11
   c. 4
   d. 16
   e. 12
   f. 6
   g. 8
   h. 9
   i. 14
   j. 7
   k. 1
   l. 10

2. Any two of the following:
   a. To spread the weight of the vehicle and its load over a greater surface
   b. To reduce the friction of wheel rotation
   c. To reduce wear to parts
   d. To provide a replaceable wear surface (wear ring)

3. a. Outer race (cup)
   b. Bore
   c. Inner race
   d. Roller

4. a. 5
   b. 17
   c. 7
   d. 8
   e. 2
   f. 1
   g. 3
   h. 13
   i. 14
   j. 12

5. a Mechanical stress (students may list rough handling, improper fit, or other examples)
   b. Fine particles in the lubricant
   c. Surface indentations on races or rollers
   d. Brinelling
   e. Flaking of the surface metal
   f. Any one of the following: Inadequate lubrication, overloading, or other source of excessive heat

6. Any four of the following:
   a. Dirt
   b. Improper assembly
   c. Misalignment
   d. Insufficient lubrication or inferior lubricants
   e. Overloading
   f. Corrosion
   g. Inferior material
   h. Incorrect grooving
   i. Incorrect clearance

7. a. Any three of the following:
      1) Noise
      2) Vehicle pulling to one side
      3) Chatter
      4) Uneven braking
      5) Shimmy
      6) Too much play in steering system
      7) Shortened bearing and seal lives
      8) Misalignment of antilock brake wheel sensors

## Answers to Written Test

- b. Any two of the following:
  - 1) Noise
  - 2) Uneven braking
  - 3) Overheating of wheel and bearing
  - 4) Vehicle pulling to one side

8. Any two of the following:
   - a. Petroleum-based lubricants
   - b. Grease
   - c. Oil
   - d. Synthetic lubricants

9. 
   - a. Vehicle
   - b. Bearing
   - c. Two
   - d. Solvent
   - e. Low
   - f. Asbestos exposure
   - g. Replace

10. 
    - a. C
    - b. I
    - c. C
    - d. I
    - e. I

11. Any two of the following:
    - a. To retain lubricants or liquids
    - b. To exclude dirt, water, and other contaminants
    - c. To separate dissimilar fluids (such as lubricating oil and water)
    - d. To confine pressure

12. One for each of the following categories:
    - a. One-piece
      - 1) Unitized
      - 2) Barrier
    - b. Multipiece
      - 1) Lip seal
      - 2) Wear rings

13. Any two of the following (in student's own words):
    - a. **Improper installation techniques or careless handling**—Could result in nicked or cut sealing surfaces, scratched shaft, distorted or cocked seal, or damaged garter spring
    - b. **Incorrect seal used for application**
      - 1) Includes seals that are the wrong size; that are used in systems with excessive speeds, temperatures, or pressures; or that use fluids incompatible with the sealing material
      - 2) Could result in seals that are brittle, cracked, hardened, excessively worn, spongy, or blown-out
    - c. **Misalignment of shaft to bore**—Commonly results in excessive wear on one side of the seal
    - d. **Shaft or bore excessive roughness, scratches, burrs, or dirt**—Can result in excessive wear to the shaft, bore, and/or seal

## Answers to Written Test

14.
   a. Scratch (or damage)
   b. Nicks or burrs
   c. Seal
   d. Wear (repair) sleeves
   e. Reuse
   f. Faces

# Wheel Bearings and Seals
# Unit 2-A

## Unit Evaluation Form

Student Name ______________________ Unit Rating __________

Assignment Sheet 1—Evaluate Worn and Damaged Wheel Bearings and Seals Rating ______

Comments: ______________________

Assignment Sheet 2—Select Appropriate Replacement Wheel Bearings and Seals Rating ______

Comments: ______________________

Job Sheet 1—Remove, Inspect, Clean, Replace, and Adjust Wheel Bearings and Seals Rating ______

Comments: ______________________

**Written Test Scores**

Pretest ______ Posttest ______ Other ______

Other ______________________

**Teacher Signature** ______________________ Date __________

**Student Signature** ______________________ Date __________

Permission to duplicate this form is granted.

# Antilock Brake Systems
# Unit 3-A

## Unit Contents

**Teacher Components** **Teacher Page**

1. Suggested Activities

a. Instructional Plan . . . . . . . . 1
b. Teaching Suggestions . . . . . . . . 2
c. Resources Used in Developing This Unit . . . . . . . . 3
d. Suggested Supplemental Resources . . . . . . . . 3
e. Instructions for Evaluating Student Performance . . . . . . . . 5

2. Transparency Master

1—Typical Antilock Brake System . . . . . . . . 7

3. Written Test . . . . . . . . 9

4. Answers to Written Test . . . . . . . . 13

5. Unit Evaluation Form . . . . . . . . 15

**Student Components** **Student Page**

DT:B

1. Objective Sheet . . . . . . . . A-47

2. Information Sheet . . . . . . . . A-49

3. Assignment Sheet

1—Diagnose and Determine Possible Causes of ABS Problems . . . . . . . . A-55

4. Job Sheets

1—Inspect, Test, and Service an Antilock Brake System . . . . . . . . A-57
2—Troubleshoot Antilock Brake System Problems . . . . . . . . A-61

# Antilock Brake Systems
# Unit 3-A

## Suggested Activities

### Instructional Plan

### Preparation

1. Read the unit carefully and plan for instruction.
2. Review "Teaching Suggestions." Plan for classroom activities.
3. Plan for students with special needs.
4. Obtain videotapes, service manuals, and other resources to supplement instruction of this unit. See "Resources" for more information.
5. Make a transparency from the transparency master included in this unit.
6. Develop teaching plan. Adjust for different learning styles.
7. Review "Instructions for Evaluating Student Performance."
8. Make copies of the Unit Evaluation Form, one for each student.

### Delivery and Application

9. Provide students with unit of instruction.
10. Discuss unit and specific objectives.
11. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
12. Discuss the assignment sheet. Review criteria for evaluation of this activity.
13. Discuss and demonstrate the job sheets. Make sure all required tools, equipment, and supplies are available. Review criteria for evaluation of these activities.

### Evaluation

14. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.
15. Make copies of the written test. Add or modify test items as needed.
16. Give written test.
17. Compile assignment sheet ratings, job sheet ratings, and written test scores on the Unit Evaluation Form. Add any additional assignments or supplemental activities that should be part of the unit evaluation.
18. Reteach and retest as required.

## Suggested Activities

### Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A Report for America 2000* and *Workplace Basics: The Skills Employers Want*. These have been adapted by MAVCC.

1. Discuss the advantages of vehicles with antilock brake systems (ABS) compared to vehicles without ABS. Also discuss any disadvantages that you and the class may see. **(Thinking Skills—Creative thinking; Technology—Application and troubleshooting)**

2. Have students identify the basic parts of an antilock brake system using a vehicle so equipped in the shop. One way to do this would be to provide students with heavyweight paper cards already labeled with the part names and have students tape the correct cards to the correct parts. This should help students see the complete system, not just the parts. **(Information—Acquisition; Systems—Interrelationships)**

3. Show students individual examples of the basic ABS components including:

    a. Exciter rings (toothed wheels)

    b. Wheel speed sensors

    c. Modulator (ABS or control) valves and relay valves, if used

    d. Electronic control unit (ECU) or controller

    e. Warning light (lamp)

    f. Wiring harness

    Discuss their different designs and operation. Show as many different examples as possible. Allow students to handle the parts and become familiar with them. **(Information—Acquisition; Technology—Selection)**

4. Discuss the most common problems that you have encountered with ABS. Also discuss how these problems affected the operation of the vehicle. Then contrast the performance of the first generation ABS with current ABS. Point out that early problems have led to resistance to adopting ABS today even though most of the early electronic problems have been corrected. **(Thinking Skills—Problem solving; Resources—Time and money; Technology—Maintenance and troubleshooting)**

5. Demonstrate and discuss the preventive maintenance required to keep ABS at optimal levels. Discuss the costs of ABS components. Even though most electronic ABS parts are replaced instead of repaired, students should still keep in mind the importance of failure analysis of faulty parts. For example, if an electrical problem is leading to ECU failures, the source of the electrical problem needs to be identified so that future failures can be prevented. **(Thinking Skills—Problem solving; Resources—Time and money; Technology—Maintenance and troubleshooting)**

6. Make a display of the special electronic tools and equipment required for troubleshooting and preventive maintenance of ABS. **(Thinking Skills—Knowing how to learn; Information—Acquisition; Technology—Selection)**

## Suggested Activities

7. Explain and demonstrate how the different manufacturers recommend diagnosing problems on ABS—what methods and techniques they recommend, what tools they use, and how they connect the diagnostic equipment to the system. Also show how they store, retrieve, and clear computer fault information. **(Thinking Skills—Decision making, problem solving, and reasoning; Technology—Selection, application, and troubleshooting)**

8. Obtain from manufacturers up-to-date service manuals, bulletins, troubleshooting guides, videos, and brochures that explain ABS. New ABS service manuals and troubleshooting guides are required for students to complete Assignment Sheet 1. **(Technology—Selection, application, and troubleshooting)**

9. Vehicles with ABS are required for students to complete both job sheets. In Job Sheet 2, there will also need to be an existing problem/fault recorded in the ABS so students will have the opportunity to troubleshoot the system and practice using the diagnostic equipment. You may need to set some of these up using faulty sensors or modulators or by moving the sensor out of alignment. **(Technology—Selection, application, and troubleshooting)**

10. Discuss with students the school policy on road tests and any special precautions, driver's license, or safety testing that is required. Make sure safety tests have been conducted, recorded, and placed in each student's permanent file. **(Personal Management Skills—Responsibility and organizational effectiveness [value of safety])**

### Resources Used in Developing This Unit

1. *Air Brake System*. Allentown, PA: Mack Truck Service Publications, 1986.

2. *The Air Brake Book*, 5th edition. Radnor, PA: Commercial Carrier Journal.

3. *Anti-lock Brake Systems for Trucks, Tractors and Buses*, Maintenance Manual No. 28. Troy, MI: Rockwell International Corporation, 1994.

4. *Anti-Lock Brake Systems for Trailers and Dollies*, Maintenance Manual No. 29. Troy, MI: Rockwell International Corporation, 1994.

5. *Antilock: Understanding It, Driving with It*. Troy, MI: Rockwell International Corporation, 1995.

6. *Brake Specialist*. Stillwater, OK: Curriculum and Instructional Materials Center/Oklahoma Department of Vocational and Technical Education, 1993.

7. Cross, Rich. *ABS Round 2*. Radnor, PA: Commercial Carrier Journal, 1997. (Printed online at http://www.ccjmagazine.com)

### Suggested Supplemental Resources

1. *Antilock Navistar Tractor*, BW1658, VHS training video.

2. *Antilock Ford*, BW1681, VHS training video.

## Suggested Activities

3. *Antilock Trailer*, VW1684, VHS training video.
4. *Antilock with Traction Control*, VW1714, VHS training video.

   1–4 are available from:

   AlliedSignal Truck Brake Systems Co.
   901 Cleveland Street
   P.O. Box 4016
   Elyria, OH 44036-2016
   1-216-329-9000

5. *Anti-lock Brakes* wall charts, large (1 987 722 608) or small T1/3-4 En). Available from:

   Robert Bosch Corporation
   Training Materials
   2740 West 79th Street
   Chicago, IL 60652
   1-800-937-2672 or fax 1-312-776-1717

6. *Modal Trailer ABS*, Part # VL31 video. Available from:

   Midland-Grau Heavy Duty Systems
   10930 N. Pomona Avenue
   Kansas City, MO 64153
   1-816-891-2470 or fax 816-891-9447

7. *ABS for Trucks, Tractors, and Buses*, Video-90140
8. *ABS Drive Information*, Video-T-9444V
9. *Truck, Tractor, and Bus ABS link Code Diagnostics*, Video-T-9501
10. *Trailer ABS Blink Code Diagnostics*, Video-T-9502V

    7–10 are available from:

    Rockwell International Corp.
    c/o Vispac, Inc.
    35000 Industrial Road
    Livonia, MI 48150
    1-248-435-8689

## Suggested Activities

### Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

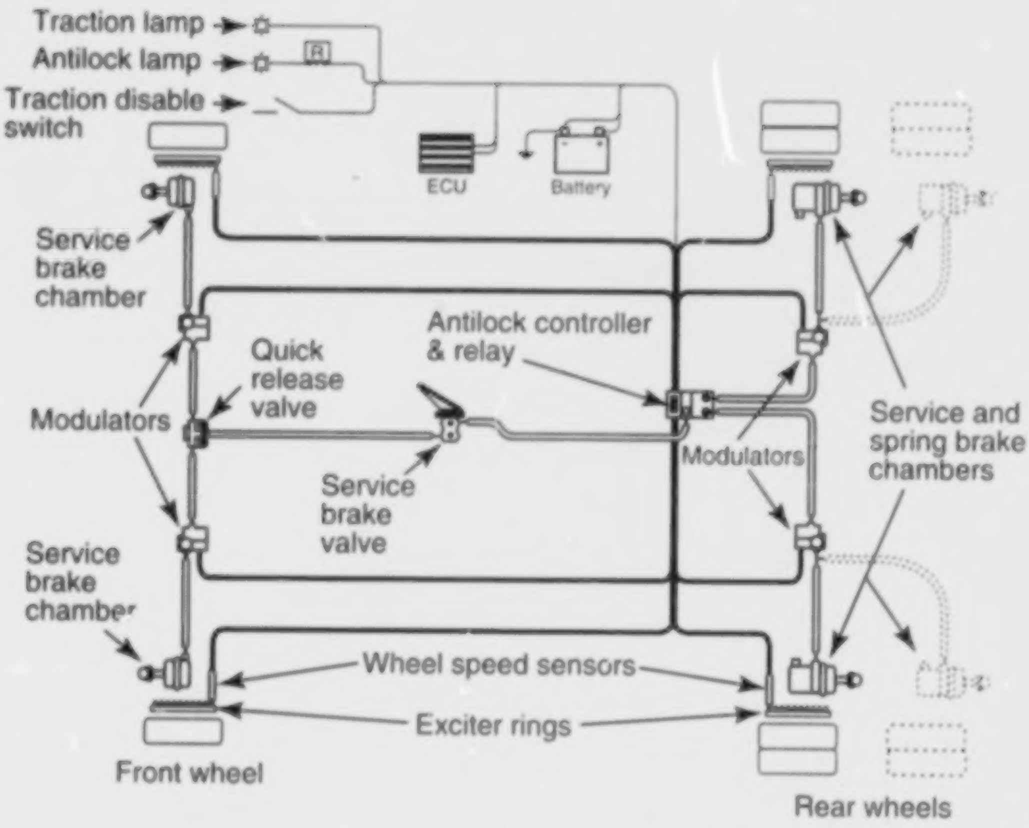
4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

Option B

Yes—Can perform job with no additional training.

No—Is unable to perform job satisfactorily.

# Typical Antilock Brake System


Traction lamp
Antilock lamp
R
Traction disable switch
ECU
Battery
Service brake chamber
Modulators
Quick release valve
Antilock controller & relay
Service brake valve
Modulators
Service and spring brake chambers
Service brake chamber
Wheel speed sensors
Exciter rings
Front wheel
Rear wheels

Courtesy of AlliedSignal Bendix

# Antilock Brake Systems
# Unit 3-A

## Written Test

Name ______________________ Date ____________ Score ____________

1. Match the terms on the right with the correct definitions.

_____ a. Electronic device that responds to a physical stimulus and then transmits a signal to a control device

_____ b. Adhesive friction between the tire and the surface on which it moves

_____ c. Road conditions where one wheel's side of the lane has a very different coefficient of friction from the other wheel's side

_____ d. Part of the service brake system that automatically controls the amount of rotational wheel slip during braking

_____ e. Difference between vehicle speed and wheel speed, expressed as a percentage

_____ f. Road conditions that are quickly changing from one coefficient of friction to another

_____ g. Electronic device that puts out light when a voltage is applied to it; commonly used on electronic displays

_____ h. To adjust or regulate a value within a desired range

_____ i. Federal agency that monitors highway safety and mandates safety regulations

_____ j. Continued movement of the vehicle after wheel lock-up

_____ k. Optional feature available on some antilock brake systems that applies braking force to a wheel that spins as a result of low traction

_____ l. Condition in which the brakes have stopped the wheels but the momentum of the moving vehicle causes it to continue to move

1. Antilock braking system
2. Channel
3. Coefficient of friction
4. Federal Motor Vehicle Safety Standards
5. Jackknife
6. Light-emitting diode
7. Lock-up
8. Modulate
9. National Highway Traffic Safety Administration
10. Sensor
11. Skid
12. Split-coefficient surfaces
13. Traction
14. Traction control
15. Transitional surfaces
16. Wheel slip

## Written Test

2. State two purposes of an antilock brake system.

a. ____________________

b. ____________________

3. Match the basic parts of an antilock brake system with the correct functions.

_______ a. Are solenoid-type valves actuated by the ECU; are located either at each wheel or on an axle set to meter the amount of air pressure to each brake or the axle's brakes

_______ b. Are electromagnetic devices mounted at the wheel end or inside an axle which combine with the exciter ring to measure wheel speed and transmit the information to the ECU

_______ c. Have notches or teeth that are read or sensed by the wheel speed sensor; are generally installed in the foundation brake area on the wheel or hub shaft

_______ d. Is a microcomputer that controls the operation of the ABS

_______ e. Indicates the status of the antilock brake system to driver and service technician

1. Electronic control unit or controller
2. Exciters, tone rings, or toothed wheels
3. Modulator valves
4. Warning light
5. Wheel speed sensors
6. Wiring harness

4. Arrange in order the steps in the basic operation of an antilock brake system by placing the correct sequence numbers (1–4) in the appropriate blanks.

_______ a. ECU constantly compares the actual wheel speed signal to the ideal wheel parameter identified in the ECU.

_______ b. Modulator responds to ECU message and adjusts braking force.

_______ c. Wheel sensor works with exciter to generate an electrical signal regarding wheel and vehicle speed.

_______ d. Exciter ring rotates with wheel.

5. List two ways to describe antilock brake systems.

a. ____________________

b. ____________________

6. Complete the following ABS time line by filling in the blanks with the correct dates or actions.

| Dates | Actions |
|---|---|
| 1974 | FMVSS 121 rule takes effect requiring specific brake performance on all new air-braked vehicles. ABS is designed to meet new requirements. |
| 1978 | Federal Court sets aside stopping distance requirement, thereby ending use of first-generation ABS devices. |
| 1979–1988 | NHTSA begins research on second generation of ABS; fleet testing begins. |
| 1991–1993 | Congress orders DOT/NHTSA to pursue ABS rule. National Transportation Safety Board recommends mandating ABS. NHTSA publishes advanced notice of rulemaking. |
| a. __________ | NHTSA issues final ABS rule, "Stability and Control Requirements for Medium and Heavy Vehicles." |
| 1997 | From March 1, all new b. ____________-braked tractors must have ABS. |
| 1998 | From March 1, all new air-braked trailers must have ABS. |
| 1999 | From March 1, all new air-braked straight trucks, buses, dollies, and trailers must have ABS. |
| 1999 | From March 1, all new c. ________________________ braked straight trucks and buses over 10,000-lb. GVWR must have ABS. |
| d. __________ | From March 1, dash-mounted trailer ABS warning light is required. |
| 2009 | From March 1, external ABS warning lights are no longer required on new trailers and dollies. |

7. Match methods of testing ABS valves with the correct descriptions.

| | | |
|---|---|---|
| _______ | a. Is a quick function check of the pneumatic valves of the ABS system; involves listening for an exhaust "pop" of the application valves | 1. Check dash panel light sequence |
| _______ | b. Is observed as the ignition key is turned to the ON position; variations such as continuous ON or continuous OFF indicate a system fault | 2. Check diagnostic display |
| _______ | c. Is a check for fault codes stored in the electronic control unit if the system has on-board or remote diagnostic displays or devices; involves the use of manufacturer's fault code lists to identify specific problems | 3. Test blow-down sequence |

## Written Test

8. Describe three of the most common problems associated with antilock brake systems.

   a. ____________________

   b. ____________________

   c. ____________________

9. Discuss two signs of antilock brake failure.

   a. ____________________

   ____________________

   b. ____________________

   ____________________

Permission to duplicate this test is granted.

# Antilock Brake Systems
## Unit 3-A

### Answers to Written Test

1. a. 10 e. 16 i. 9
   b. 13 f. 15 j. 11
   c. 12 g. 6 k. 14
   d. 1 h. 8 l. 7

2. Any two of the following:
   a. To prevent wheels from locking up such as during panic stops
   b. To prevent wheels from skidding such as on slippery road surfaces
   c. To prevent jackknives when driving a combination vehicle
   d. To maintain vehicle stability and steering control

3. a. 3
   b. 5
   c. 2
   d. 1
   e. 4

4. a 3
   b. 4
   c. 2
   d. 1

5. a. By number of channels (Number of ABS modulators)
   b. By alphanumeric descriptors (Number of sensors and number of modulators)

6. a. 1995
   b. Air
   c. Hydraulically
   d. 2001

7. a. 3
   b. 1
   c. 2

8. Any three of the following:
   a. Wheel sensors out of adjustment (usually excessive air gap between exciter ring and sensor)
   b. Worn or damaged sensor or modulator
   c. Loose, damaged, or corroded wiring and/or connectors
   d. Faulty warning indicator lights
   e. Non-functioning ECU

## Answers to Written Test

9. Any two of the following:
   a. Improper vehicle motion—When brakes are applied on slippery surfaces, vehicle skids, plows out, locks up, or experiences trailer swing. Antilock brakes do not operate.
   b. Improper ABS braking—Antilock system is activated unnecessarily, when normal braking should be possible.
   c. Visible signs of ABS damage—Cracks, leaks, frayed wires, or other indications can be seen by driver or service technician.
   d. Instrument indicators—Warning lights and diagnostic displays alert the driver or service technician to malfunctions.

# Antilock Brake Systems
## Unit 3-A

### Unit Evaluation Form

Student Name ______________________ Unit Rating __________

Assignment Sheet 1—Diagnose and Determine Possible Causes of ABS Problems Rating ______

Comments: ______________________

Job Sheet 1—Inspect, Test, and Service an Antilock Brake System Rating ______

Comments: ______________________

Job Sheet 2—Troubleshoot Antilock Brake System Problems Rating ______

Comments: ______________________

**Written Test Scores**

Pretest ________ Posttest ________ Other ________

Other ______________________

**Teacher Signature** ______________________ Date __________

**Student Signature** ______________________ Date __________

Permission to duplicate this form is granted.

# Hydraulic Foundation Drum Brakes
## Unit 1-B

## Unit Contents

**Teacher Components** **Teacher Page**

1. Suggested Activities
    - a. Instructional Plan ..... 1
    - b. Teaching Suggestions ..... 2
    - c. Resources Used in Developing This Unit ..... 2
    - d. Suggested Supplemental Resources ..... 3
    - e. Instructions for Evaluating Student Performance ..... 3
2. Transparency Masters
    - 1—Components of a Drum Brake Assembly ..... 5
    - 2—Parts of a Brake Shoe ..... 7
    - 3—Types of Brake Shoes ..... 9
3. Written Test ..... 11
4. Answers to Written Test ..... 17
5. Unit Evaluation Form ..... 19

**Student Components** **Student Page**

DT:B

1. Objective Sheet ..... B-1
2. Information Sheet ..... B-3
3. Job Sheets
    - 1—Remove, Clean, Inspect, and Measure a Brake Drum ..... B-11
    - 2—Remove, Inspect, and Replace Brake Shoes and Related Hardware ..... B-15
    - 3—Replace Brake Drum and Adjust Brake Clearance ..... B-19

# Hydraulic Foundation Drum Brakes
## Unit 1-B

## Suggested Activities

### Instructional Plan

### Preparation

1. Read the unit carefully and plan for instruction.
2. Review "Teaching Suggestions." Plan for classroom activities.
3. Plan for students with special needs.
4. Obtain videotapes, service manuals, and other resources to supplement instruction of this unit. See "Resources" for more information.
5. Make transparencies from the transparency masters included in this unit.
6. Develop teaching plan. Adjust for different learning styles.
7. Review "Instructions for Evaluating Student Performance."
8. Make copies of the Unit Evaluation Form, one for each student.

### Delivery and Application

9. Provide students with unit of instruction.
10. Discuss unit and specific objectives.
11. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
12. Discuss and demonstrate the job sheets. Make sure all required tools, equipment, and supplies are available. Review criteria for evaluation of these activities.

### Evaluation

13. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.
14. Make copies of the written test. Add or modify test items as needed.
15. Give written test.
16. Compile job sheet ratings and written test scores on the Unit Evaluation Form. Add any additional assignments or supplemental activities that should be part of the unit evaluation.
17. Reteach and retest as required.

## Suggested Activities

### Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A Report for America 2000* and *Workplace Basics: The Skills Employers Want.* These have been adapted by MAVCC.

1. Discuss how hydraulic foundation drum brakes (HFDB) differ from disc brakes. Have students list the types of vehicles that use HFDB. **(Thinking Skills—Reasoning)**

2. Have students identify the basic components of a drum brake assembly using a vehicle so equipped in the shop and/or disassembled parts. By seeing the actual parts and their relationship to the braking system, the student will be better prepared to complete the job sheets. **(Information—Acquisition; Systems—Interrelationships)**

3. Discuss the most common problems that you have encountered with HFDB. Also discuss how these problems affected the operation of the vehicle. **(Thinking Skills—Problem solving; Technology—Maintenance and troubleshooting)**

4. Show examples of brake shoe defects and discuss their causes. Have students practice inspecting brake shoes for damage. **(Thinking Skills—Problem solving; Technology—Maintenance and troubleshooting)**

5. Demonstrate and discuss the preventive maintenance required to keep HFDB at optimal levels. Discuss the costs for replacing parts and the importance of failure analysis of faulty parts to prevent further damage to braking system or even to prevent an accident should the brakes fail. **(Thinking Skills—Problem solving; Resources—Time and money; Technology—Maintenance and troubleshooting)**

6. Obtain from manufacturers up-to-date service manuals, bulletins, troubleshooting guides, videos, and brochures that explain HFDB. Provide these to students so that they may study the resources available to them when working on specific brakes. **(Basic Skills—Reading; Thinking Skills—Knowing how to learn; Technology—Application and troubleshooting)**

7. Discuss safety precautions to follow when working on HFDB. Point out previous problems that could have been prevented if students had observed the rules. **(Personal Management Skills—Responsibility and organizational effectiveness [value of safety])**

### Resources Used in Developing This Unit

1. *Brakes Specialist.* Stillwater, OK: Curriculum and Instructional Materials Center/Oklahoma Department of Vocational and Technical Education, 1993.

2. Byrnes, Mike and Associates. *Bumper to Bumper.* Phoenix, AZ: Barron's Educational Series, Inc., 1993.

3. *Drum Brake Service Manual.* Galesburg, MI: Eaton Corporation, Brake Division, 1982.

4. *Ford Medium Truck Hydraulic Brakes.* Detroit, MI: Ford Parts and Service Division, Training and Publications Department, 1987.

5. *Grey-Rock Heavy Duty Brake Service Manual.* Owosso, MI: Grey-Rock, 1983.

6. Schultz, Erich J. *Diesel Equipment I: Lubrication, Hydraulics, Brakes, Wheels, Tires.* Lake Forest, IL: Glencoe Division of Macmillan/McGraw-Hill Publishing Company, 1991.

## Suggested Activities

### Suggested Supplemental Resources

1. *Drum Brakes Manual*, (Item #P-9075-1). Explains operation and repair of 1969-1985 General Motors models. 64 pages. Available from:

   Automotive Service Association
   P.O. Box 929
   Bedford, TX 76095-0929
   1-817-283-6205, 1-800-272-7467, or fax 1-817-685-0225

2. *Heavy Duty Brake Drum Maintenance Manual*, (Item #3-10/DM-95)

3. Brake Drum Video, 6-minute VHS videotape.

4. Automatic Slack Adjuster Video, 10-minute VHS videotape.

   2, 3, and 4 are available from:

   Gunite Fleet Line Products
   302 Peoples Avenue
   Rockford, IL 61104-7092
   1-800-677-DRUM (3786), 1-815-965-9197, or fax 1-815-964-0775

### Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

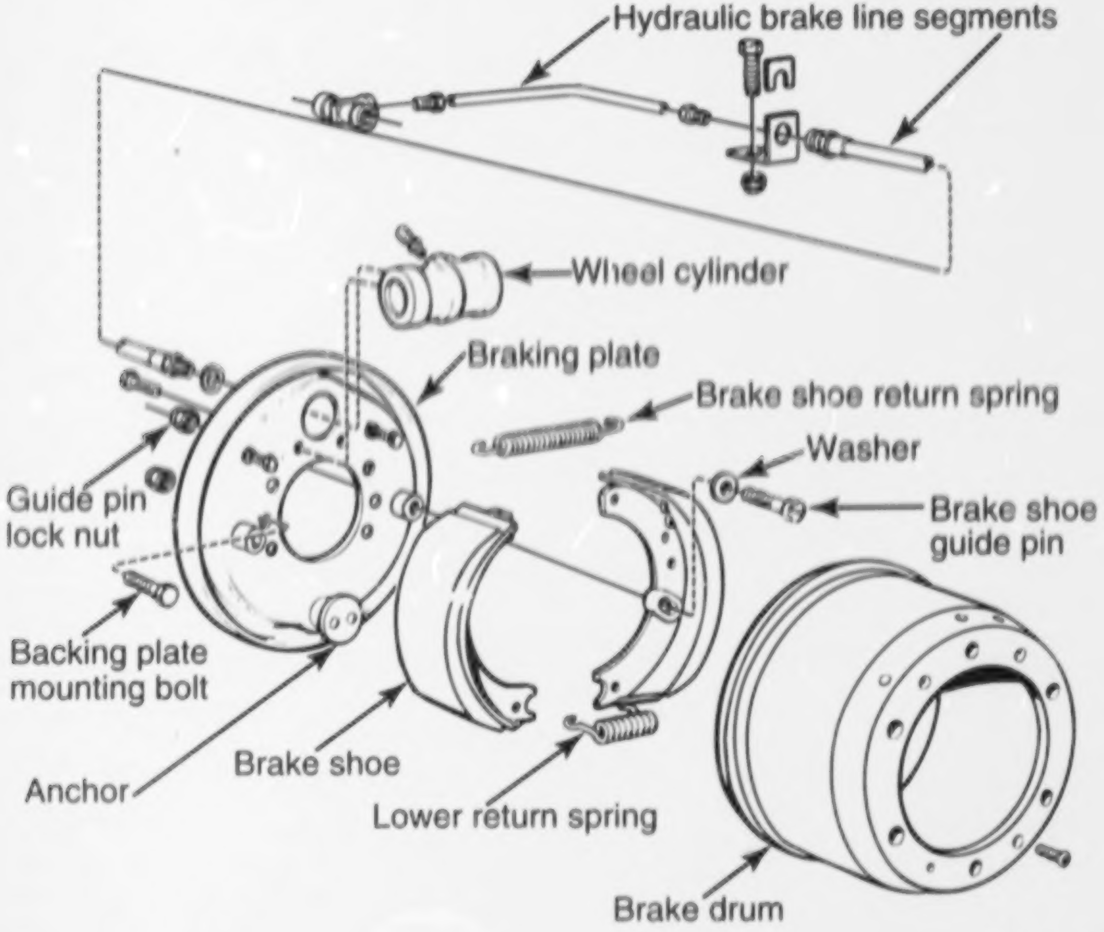
4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

Option B

Yes—Can perform job with no additional training.

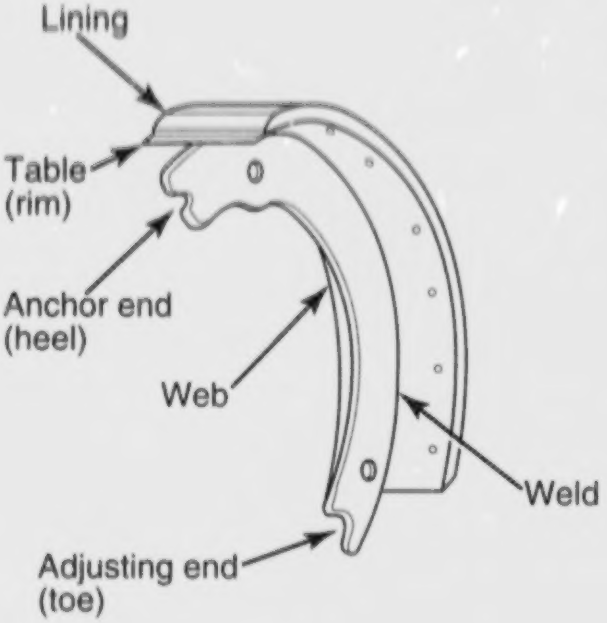
No—Is unable to perform job satisfactorily.

# Components of a Drum Brake Assembly

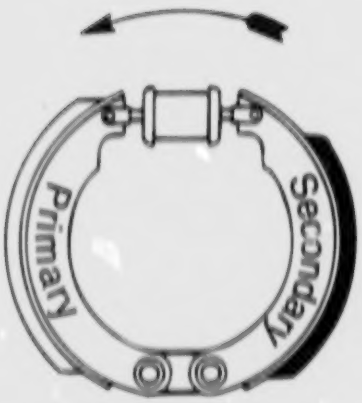

Hydraulic brake line segments
Wheel cylinder
Braking plate
Brake shoe return spring
Washer
Brake shoe guide pin
Guide pin lock nut
Backing plate mounting bolt
Anchor
Brake shoe
Lower return spring
Brake drum

Courtesy of Haldex Midland Services

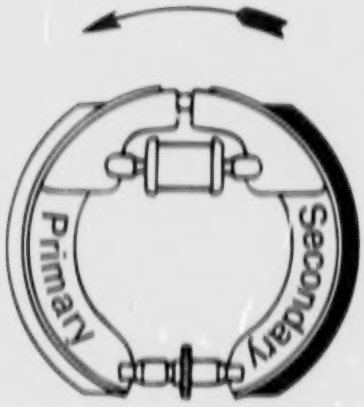
# Parts of a Brake Shoe


Lining
Table (rim)
Anchor end (heel)
Web
Weld
Adjusting end (toe)

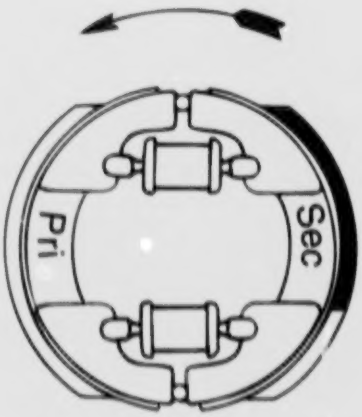
# Types of Brake Shoes


Primary
Secondary

**Non-Servo**


Primary
Secondary

**Single Cylinder Duo-Servo**



**Double Cylinder**

Courtesy of Haldex Midland Services

## Hydraulic Foundation Drum Brakes
## Unit 1-B

### Written Test

Name ______________________ Date ____________ Score ____________

1. Match the terms on the right with the correct definitions.

_____ a. To use lathes, drills, or other equipment to change the shape or surface finish of metal

_____ b. Referring to circles that have different centers

_____ c. Part of wheel assembly which is engaged by the brakes to slow or stop the vehicle

_____ d. Mechanical components that provide braking force

_____ e. Condition of a hole becoming enlarged due to wear from a part moving loosely inside it

_____ f. Condition of being hardened by the application of heat

_____ g. Mechanical part in which a circle is enlarged in one area so that the rotation of the part causes movement of another part when the enlarged area contacts the other part

_____ h. To become deformed as a result of excessive heat or pressure

_____ i. Term applied to braking system whose design allows braking force to be multiplied by friction

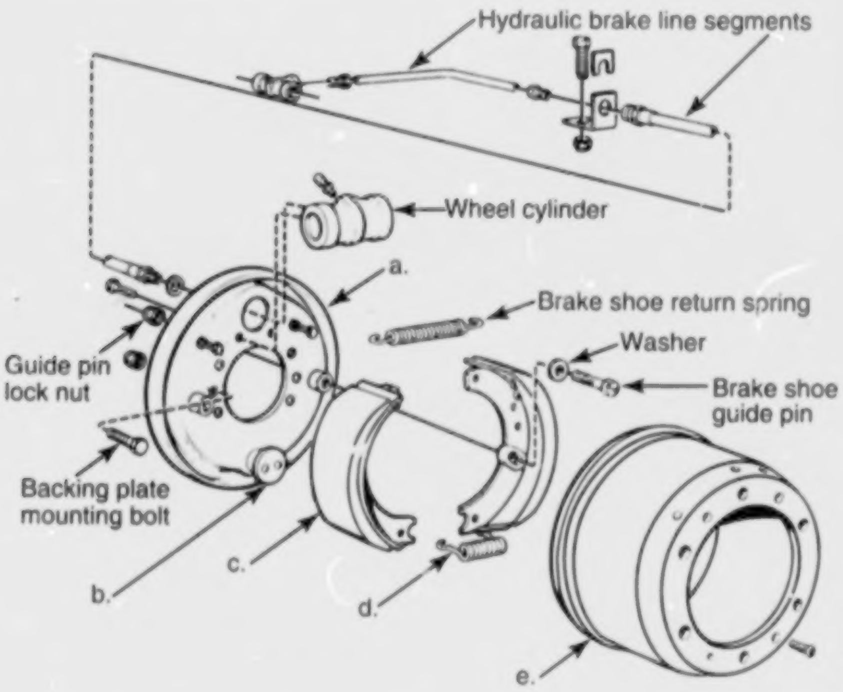
_____ j. Shaped metal part used in brake systems to hold brake shoes apart

_____ k. Deterioration of a cable in which individual strands of the cable are broken or worn

1. Adjust
2. Cam
3. Concentric
4. Drum
5. Eccentric
6. Foundation brakes
7. Frayed
8. Machine
9. Orientation
10. Self-energizing
11. Shoe-to-drum clearance
12. Strut
13. Tempered
14. Wallowing
15. Warps

## Written Test

2. Identify the components of a drum brake assembly. Write your answers in the blanks below.


Hydraulic brake line segments
Wheel cylinder
a.
Brake shoe return spring
Washer
Brake shoe guide pin
Guide pin lock nut
Backing plate mounting bolt
b.
c.
d.
e.

Courtesy of Haldex Midland Services

a. ________________________________

b. ________________________________

c. ________________________________

d. ________________________________

e. ________________________________

## Written Test

3. Match the components of a drum brake assembly on the right with their functions.

_______ a. Holds the shoe to the backing plate while allowing limited movement of the shoe; may be springs, bolts, guide pins, or clips

_______ b. Provides base for drum brake assembly onto which other parts are mounted

_______ c. Exerts pressure on the inside of the drum on the side of the brake assembly toward the front of a forward moving vehicle

_______ d. Holds one end of the shoes in place to allow the shoes to pivot to make contact with the brake drum; may be single or double

_______ e. Returns shoes to unactuated position

_______ f. Serves as portion of wheel assembly against which the brake shoes apply pressure to stop the rotation of the wheel

1. Adjuster hardware
2. Anchor
3. Backing plate
4. Brake drum
5. Hold-down
6. Primary shoe
7. Secondary shoe
8. Shoe spring
9. Wheel cylinder

4. Match drum and hub assembly defects on the right with their descriptions.

_______ a. Drum or hub diameter is not equal around entire assembly

_______ b. Inside diameter of drum is not within acceptable tolerance

_______ c. Scratches and cuts in the surface of the drum

_______ d. Uneven wear of the drum leading to a greater diameter on the inboard side of the drum

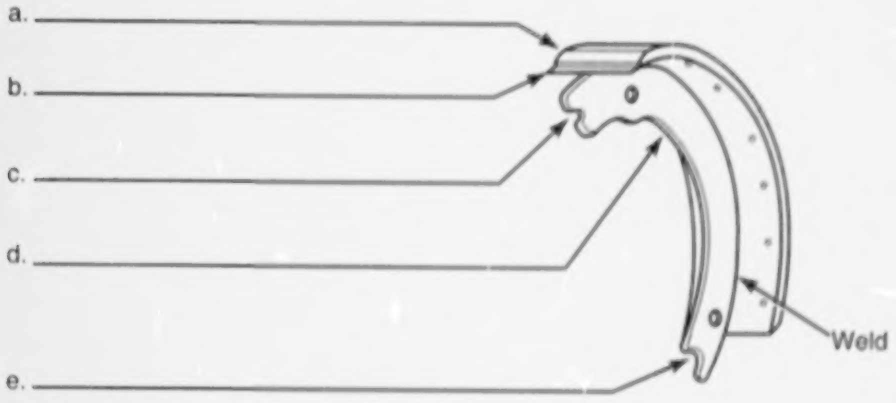
_______ e. Tempered areas of metal that become visible when the drum is machined

_______ f. Thin cracks in the surface of the drum braking surface

_______ g. Center of the hub and center of the outside of the drum are not the same

1. Bell-mouthed condition
2. Cracks or breaks in the drum
3. Eccentric condition
4. Hard spotting
5. Heat checking
6. Improper wheel mounting hardware
7. Incorrect diameter
8. Out-of-round condition
9. Scoring

5. Label the parts of a brake shoe.



6. Match the parts of a brake shoe on the right with their functions.

_______ a. Contacts drum to provide friction to stop wheel rotation

_______ b. Reinforces table and provides means of mounting hardware for brake operation

_______ c. Provides a surface to which the lining can be mounted

_______ d. Binds table and web together

_______ e. Positions shoe and prevents shoe from rotation with drum

1. Adjusting end (toe)
2. Anchor end (heel)
3. Lining
4. Table (rim)
5. Web
6. Weld

7. Distinguish between types of brake shoe applications by placing an "X" next to the description of a non-servo brake shoe.

_______ a. Has double wheel piston cups applying equal force in both directions at both ends of the shoes

_______ b. Has dual wheel cylinder pistons that apply equal force on the primary and secondary shoes; force is multiplied by the rotation of primary shoe against the secondary shoe forcing against the brake drum

_______ c. As brake is applied, the shoes apply force independently because of the bottom anchor

## Written Test

8. Distinguish between the types of brake shoe materials by placing an "O" next to the description(s) of organic shoe material and an "S" next to the description(s) of semimetallic shoe material.

_______ a. Used for severe duty only

_______ b. Consist of fiber, organic materials, and resins/bonding agents

_______ c. Consist of aluminum, lead, silicas, and other ingredients mixed with resin and molded into shape

_______ d. Most commonly used type

9. Match brake shoe defects on the right with their descriptions.

_______ a. Inadequate lining remains for proper braking

_______ b. Surface of the shoe lining is hard and smooth

_______ c. Surface of the shoe lining contains cuts and streaks

_______ d. Surface of the shoe lining contains relatively deep scratches or pits

_______ e. Bending, wear, or warping of the table or web of the shoe

1. Cracks
2. Excessive wear
3. Glazing
4. Gouging
5. Oil or grease contamination
6. Scoring
7. Shoe deformities

10. Match drum brake hardware on the right with their uses.

_______ a. Provide stationary mounting point or positioning guide

_______ b. Transmit force from one part to another with a pulling motion

_______ c. Provides means of adjusting position of shoes

_______ d. Transmit force from one part to another through a pivoting motion

_______ e. Position movable parts, such as holding parts in relation to one another or returning a part to a previous position

_______ f. Hold parts together where excessive pressure is not a problem

1. Adjuster hardware
2. Cables and links
3. Clips
4. Levers
5. Pins
6. Springs

## Written Test

11. Complete statements concerning the adjustment of drum brake assemblies by filling in the blanks with the correct answers.

    a. The clearance between shoe and ____________________ is adjusted using a manual or automatic adjustment mechanism.

    b. Manual adjustment mechanism may use ________________________ to lengthen or shorten the clearance distance.

    c. ________________________ adjustment mechanism is a periodic maintenance item.

    d. Automatic adjustment mechanisms commonly use ____________________ that turn the star wheel as the lining wears.

12. List two conditions to inspect in both manual and automatic drum brake adjustment systems.

    a. Manual adjustment

        1) ________________________________________________

        2) ________________________________________________

    b. Automatic adjustment

        1) ________________________________________________

        2) ________________________________________________

Permission to duplicate this test is granted.

121

# Hydraulic Foundation Drum Brakes
## Unit 1-B

### Answers to Written Test

1. a. 8
   b. 5
   c. 4
   d. 6
   e. 14
   f. 13
   g. 2
   h. 15
   i. 10
   j. 12
   k. 7

2. a. Backing plate
   b. Anchor
   c. Brake shoe
   d. Return spring (lower)
   e. Brake drum

3. a. 5
   b. 3
   c. 6
   d. 2
   e. 8
   f. 4

4. a 8
   b. 7
   c. 9
   d. 1
   e. 4
   f. 5
   g. 3

5. a. Lining
   b. Table (rim)
   c. Anchor end (heel)
   d. Web
   e. Adjusting end (toe)

6. a. 3
   b. 5
   c. 4
   d. 6
   e. 2

7. c

8. a. S
   b. O
   c. S
   d. O

9. a. 2
   b. 3
   c. 6
   d. 4
   e. 7

10. a. 5
    b. 2
    c. 1
    d. 4
    e. 6
    f. 3

11. a. Drum
    b. Star wheels or centric adjusting devices
    c. Manual
    d. Cables or links

## Answers to Written Test

12. a. Manual adjusting—Any two of the following:
    1) Teeth on star wheel
    2) Threads on adjusting screw and pivot nut
    3) Improper seating of slots
    4) Freedom of movement in star wheel, cam, or other adjustment mechanism
    5) Access plug is installed

    b. Automatic adjustment—Any two of the following:
    1) Adjustment mechanism engages adjuster
    2) Linkages free of wear
    3) Linkages free of deformities and damage
    4) Free movement of all parts
    5) Operation of related parts

# Hydraulic Foundation Drum Brakes
# Unit 1-B

## Unit Evaluation Form

Student Name ______________________ Unit Rating __________

Job Sheet 1—Remove, Clean, Inspect, and Measure a Brake Drum Rating ______

Comments: ______________________________________________

_______________________________________________________

Job Sheet 2—Remove, Inspect, and Replace Brake Shoes and Related Hardware Rating ______

Comments: ______________________________________________

_______________________________________________________

Job Sheet 3—Replace Brake Drum and Adjust Brake Clearance Rating ______

Comments: ______________________________________________

_______________________________________________________

**Written Test Scores**

Pretest ________ Posttest ________ Other ________

Other _________________________________________________

_______________________________________________________

**Teacher Signature** ______________________ Date __________

**Student Signature** ______________________ Date __________

Permission to duplicate this form is granted.

# Hydraulic Foundation Disc Brakes
# Unit 2-B

## Unit Contents

**Teacher Components** **Teacher Page**

1. Suggested Activities

    a. Instructional Plan . . . . . 1
    b. Teaching Suggestions . . . . . 2
    c. Resources Used in Developing This Unit . . . . . 2
    d. Suggested Supplemental Resources . . . . . 3
    e. Instructions for Evaluating Student Performance . . . . . 3

2. Transparency Masters

    1—Parts of a Front Disc Brake . . . . . 5
    2—Parts of a Rear Disc Brake . . . . . 7
    3—Parts of a Brake Caliper . . . . . 9

3. Written Test . . . . . 11

4. Answers to Written Test . . . . . 17

5. Unit Evaluation Form . . . . . 19

**Student Components** **Student Page**

DT:B

1. Objective Sheet . . . . . B-23

2. Information Sheet . . . . . B-25

3. Job Sheets

    1—Remove, Clean, and Inspect a Caliper and Pad Assembly . . . . . B-31
    2—Inspect, Measure, Remove, and Reinstall a Rotor Assembly . . . . . B-35
    3—Reinstall Caliper and Pad Assembly and Check Brake Operation . . . . . B-39

# Hydraulic Foundation Disc Brakes
## Unit 2-B

### Suggested Activities

**Instructional Plan**

**Preparation**

1. Read the unit carefully and plan for instruction.

2. Review "Teaching Suggestions." Plan for classroom activities.

3. Plan for students with special needs.

4. Obtain videotapes, service manuals, and other resources to supplement instruction of this unit. See "Resources" for more information.

5. Make transparencies from the transparency masters included in this unit.

6. Develop teaching plan. Adjust for different learning styles.

7. Review "Instructions for Evaluating Student Performance."

8. Make copies of the Unit Evaluation Form, one for each student.

**Delivery and Application**

9. Provide students with unit of instruction.

10. Discuss unit and specific objectives.

11. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.

12. Discuss and demonstrate the job sheets. Make sure all required tools, equipment, and supplies are available. Review criteria for evaluation of these activities.

**Evaluation**

13. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.

14. Make copies of the written test. Add or modify test items as needed.

15. Give written test.

16. Compile job sheet ratings and written test scores on the Unit Evaluation Form. Add any additional assignments or supplemental activities that should be part of the unit evaluation.

17. Reteach and retest as required.

## Suggested Activities

### Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A Report for America 2000* and *Workplace Basics: The Skills Employers Want.* These have been adapted by MAVCC.

1. Discuss how hydraulic foundation disc brakes work and how they have improved over the years. **(Basic Skills—Listening; Information—Acquisition)**

2. Have students identify the parts of a front disk brake and a rear disc brake using actual parts. **(Thinking Skills—Reasoning)**

3. Discuss the most common problems that you have encountered with hydraulic foundation disc brakes. Also discuss how the problems affected the operation of the vehicle. **(Thinking Skills—Problem solving; Technology—Maintenance and troubleshooting)**

4. Show examples of rotor and brake pad defects and discuss their causes. Have students practice inspecting parts for damage. **(Thinking Skills—Problem solving; Technology—Maintenance and troubleshooting)**

5. Demonstrate and discuss the preventive maintenance required to keep disc brakes at optimal levels. Discuss the costs of replacing parts and the importance of failure analysis of faulty parts to prevent further damage to braking system or even to prevent an accident. **(Thinking Skills—Problem solving; Resources—Time and money; Technology—Maintenance and troubleshooting)**

6. Obtain manufacturers up-to-date service manuals, bulletins, troubleshooting guides, videos, and brochures that explain hydraulic foundation disc brakes. Provide these to students so that they may study the resources available to them when working on specific brakes. **(Basic Skills—Reading; Thinking Skills—Knowing how to learn; Technology—Application and troubleshooting)**

7. Discuss safety precautions to follow when working on disc brakes. Point out previous problems that could have been prevented if students had observed the rules. **(Personal Management Skills—Responsibility and organizational effectiveness [value of safety])**

### Resources Used in Developing This Unit

1. *Brakes Specialist.* Stillwater, OK: Curriculum and Instructional Materials Center/Oklahoma Department of Vocational and Technical Education, 1993.

2. *Ford Medium Truck Hydraulic Brakes.* Detroit, MI: Ford Parts and Service Division, Training and Publications Department, 1987.

3. *GM 1997 Medium Duty Truck C Series and B7 Chassis Service Manual-GMT/97-MD530*, Book 1 of 2. Detroit, MI: General Motors Corporation, 1997.

4. *Hydraulic Disc Brakes: Medium Duty Truck.* Warren, MI: General Motors Corporation, 1983.

5. Norman, Ian Andrew et al. *Heavy Duty Truck Systems.* 2nd ed. Albany, NY: Delmar Publishers, Inc., 1996.

6. Schultz, Erich J. *Diesel Equipment I: Lubrication, Hydraulics, Brakes, Wheels, Tires.* Lake Forest, IL: Glencoe Division of Macmillan/McGraw-Hill Publishing Company, 1991.

## Suggested Supplemental Resources

1. Disc Wheel Hub Maintenance Manual, (# 3-13).
2. Disc Brake Rotor Maintenance Manual, (# 3-12).

1 and 2 are available from:

Gunite Fleet Line Products
302 Peoples Avenue
Rockford, IL 61104-7092
1-800-677-DRUM (3786), 1-815-965-9197, or fax 1-815-964-0775

3. Hydraulic Disc Brakes: Medium Duty Truck Manual, (Item # P-9068). Introduction to General Motors hydraulic disc brakes. 72 pages. Available from:

Automotive Service Association
P.O. Box 929
Bedford, TX 76095-0929
1-817-283-6205, 1-800-272-7467, or fax 1-817-685-0225

## Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

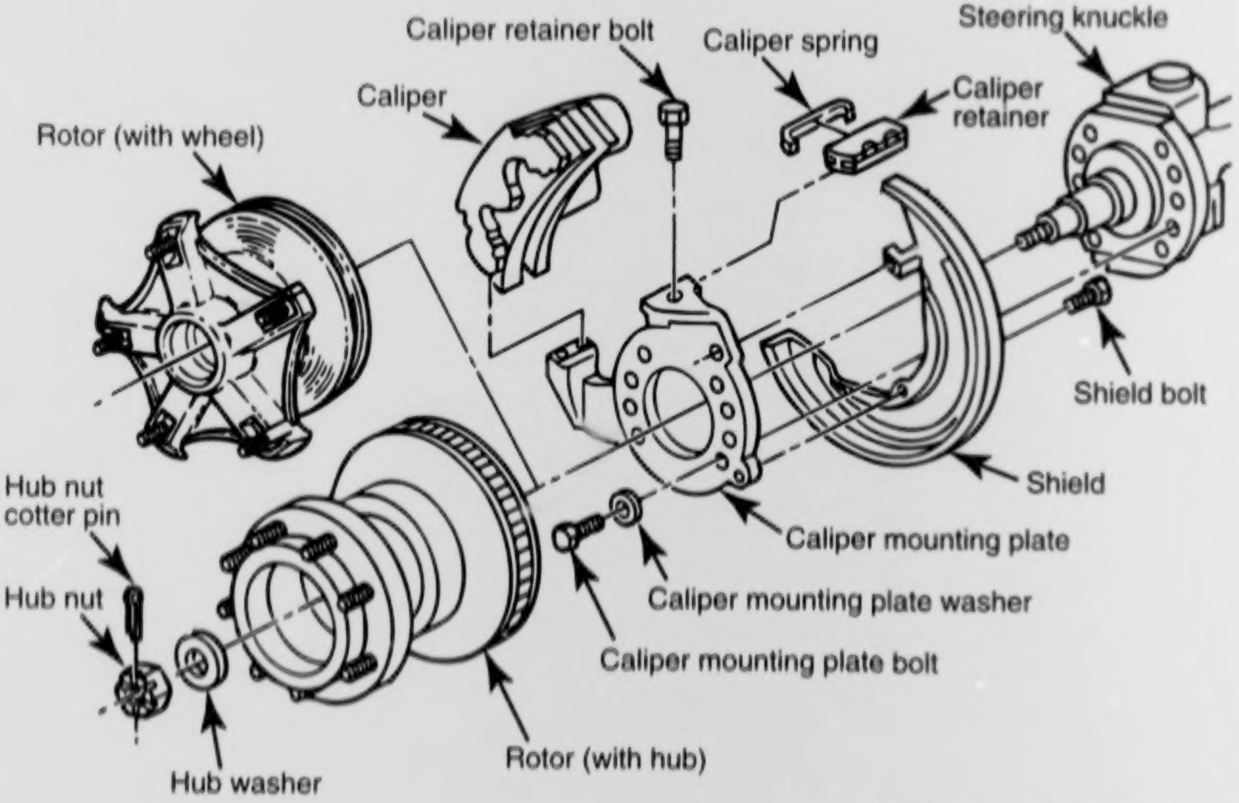
4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

Option B

Yes—Can perform job with no additional training.

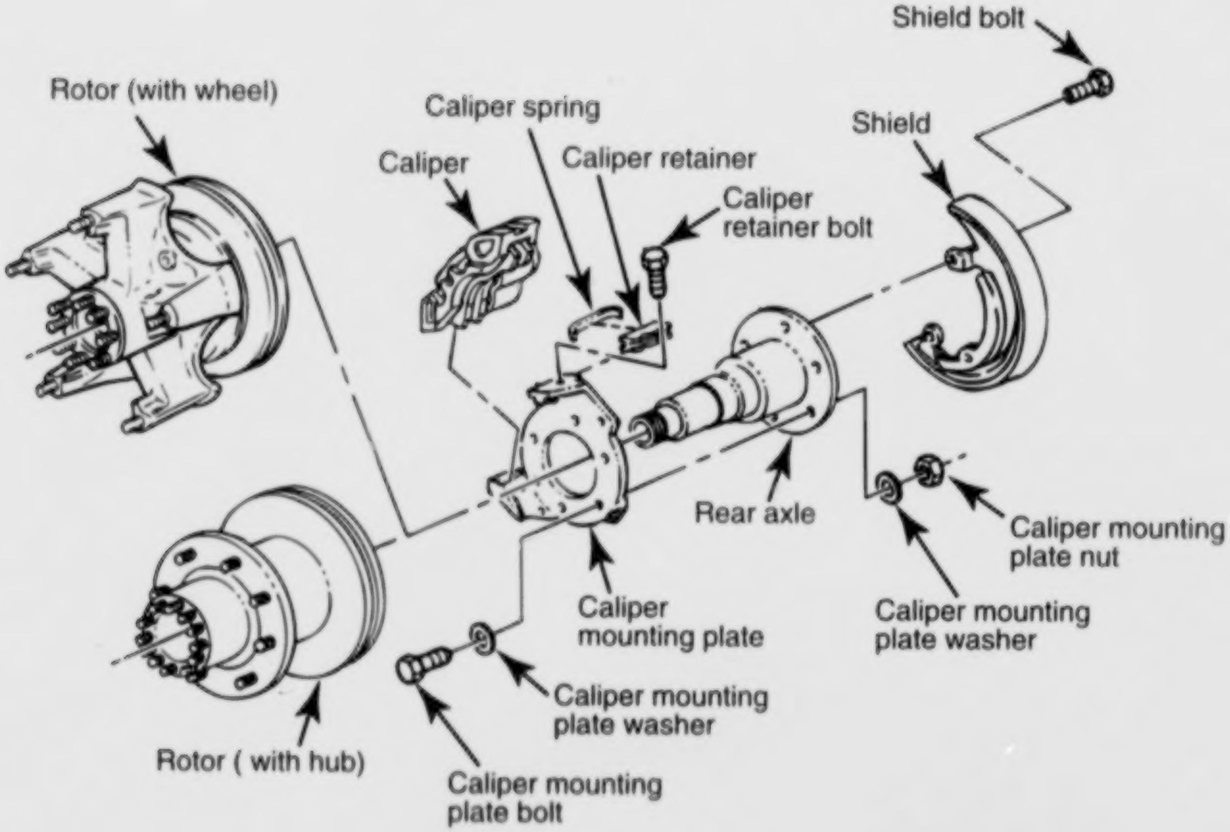
No—Is unable to perform job satisfactorily.

# Parts of a Front Disc Brake


Caliper retainer bolt
Caliper spring
Steering knuckle
Caliper
Caliper retainer
Rotor (with wheel)
Shield bolt
Shield
Hub nut cotter pin
Caliper mounting plate
Caliper mounting plate washer
Hub nut
Caliper mounting plate bolt
Rotor (with hub)
Hub washer

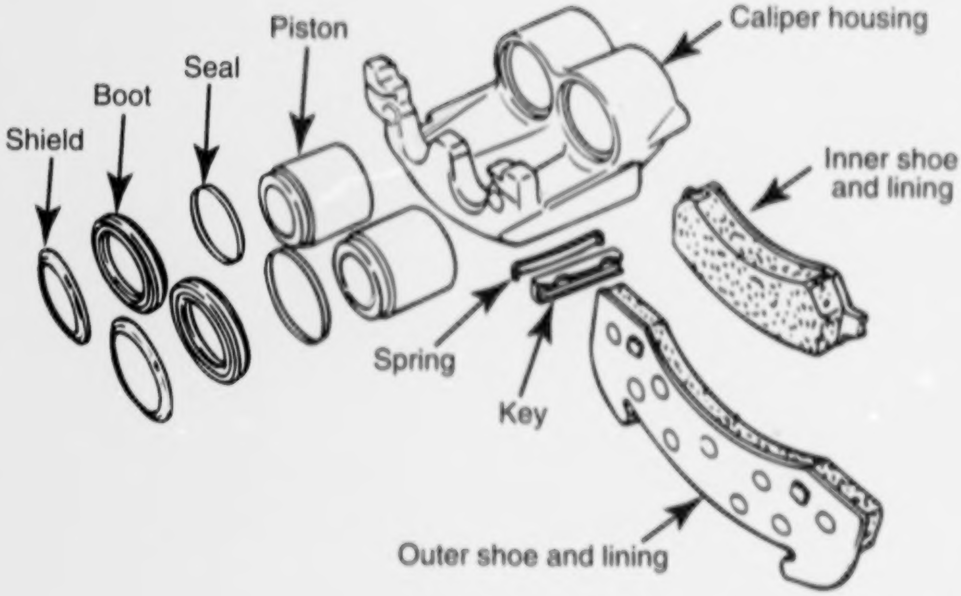
Reprinted with permission of General Motors Corporation

# Parts of a Rear Disc Brake


Shield bolt
Rotor (with wheel)
Caliper spring
Shield
Caliper
Caliper retainer
Caliper retainer bolt
Rear axle
Caliper mounting plate nut
Caliper mounting plate
Caliper mounting plate washer
Caliper mounting plate washer
Rotor ( with hub)
Caliper mounting plate bolt

Reprinted with permission of General Motors Corporation

# Parts of a Brake Caliper


Piston
Caliper housing
Seal
Boot
Shield
Inner shoe and lining
Spring
Key
Outer shoe and lining

Reprinted with permission of General Motors Corporation

# Hydraulic Foundation Disc Brakes
## Unit 2-B

### Written Test

Name ______________________________ Date ____________ Score ____________

1. Match the terms on the right with the correct definitions.

_______ a. To restore to a like-new condition

_______ b. Devices used in conjunction with brake assemblies to reduce the noise and vibration in the assembly

_______ c. Disc brake design in which the rotor has vanes in th edge to dissipate heat

_______ d. Circular metal component used in some brake system designs as the friction surface for the wheel assembly during braking

_______ e. To restore a surface to a specified (like-new) condition

1. Disc
2. Noise suppressants
3. Recondition
4. Resurface
5. Ventilated

2. Match the parts of a front disc brake listed below with their illustrations and illustration numbers. Place your answers (numbers) in the blanks provided.

_______ a. Caliper

_______ b. Caliper mounting plate

_______ c. Shield

_______ d. Rotor (with wheel)

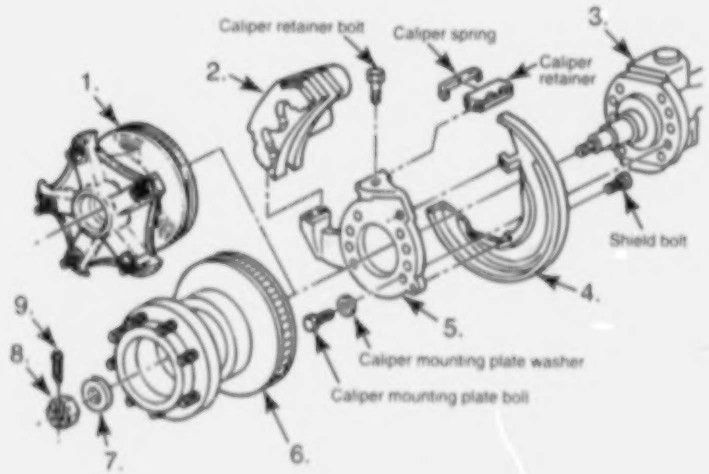
_______ e. Rotor (with hub)

_______ f. Hub nut

_______ g. Hub nut cotter pin

_______ h. Hub washer

_______ i. Steering knuckle


Caliper retainer bolt
Caliper spring
Caliper retainer
1.
2.
3.
4.
5.
6.
7.
8.
9.
Shield bolt
Caliper mounting plate washer
Caliper mounting plate bolt

Reprinted with permission of General Motors Corporation

## Written Test

3. Match the parts of a rear disc brake listed below with their illustrations and illustration numbers. Place your answers (numbers) in the blanks provided.

_______ a. Caliper

_______ b. Caliper mounting plate

_______ c. Caliper retainer

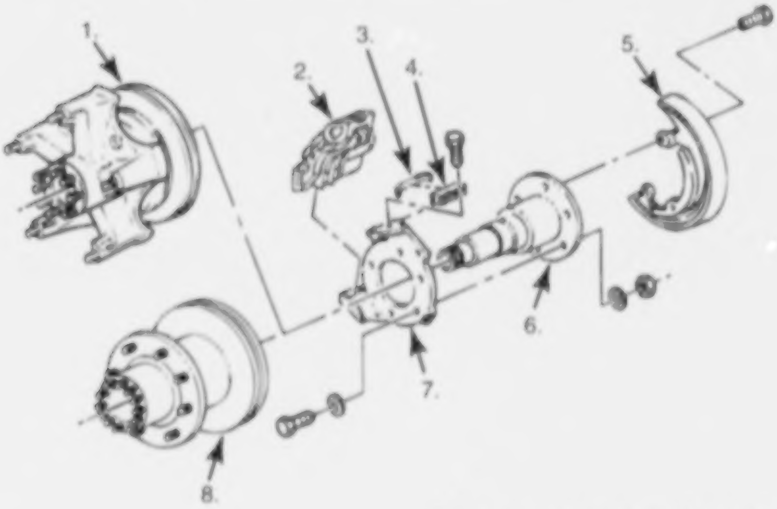
_______ d. Caliper spring

_______ e. Rear axle

_______ f. Rotor (with hub)

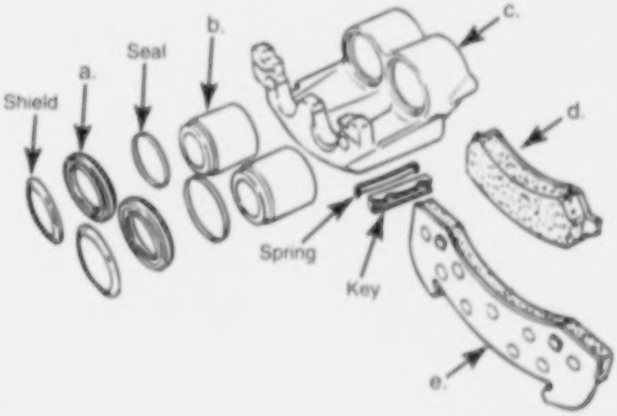
_______ g. Rotor (with wheel)

_______ h. Shield



Reprinted with permission of General Motors Corporation

4. Identify the following parts of a brake caliper. Write your answers in the blanks provided.



Reprinted with permission of General Motors Corporation

a. ______________________________ b. ______________________________

c. ______________________________ d. ______________________________

e. ______________________________

## Written Test

5. Match the components of disc brake assemblies on the right with their functions.

_______ a. Provides portion of wheel assembly against which the brake pads apply pressure to stop the rotation of the wheel

_______ b. Hold the caliper assembled

_______ c. Exert pressure on the rotor

_______ d. Houses the hydraulic piston and related hardware that actuates the pads

_______ e. Transmits hydraulic force to the pads to push them against the rotor

_______ f. Holds caliper in position over rotor

1. Caliper
2. Caliper housing support
3. Mounting plate and bolts
4. Pads (shoes and linings)
5. Piston
6. Rotor (disc)
7. Shield

6. Describe the types of brake calipers.

a. Classified by installation method

_______________________________________________

_______________________________________________

b. Classified by piston count

_______________________________________________

_______________________________________________

7. Match rotor defects on the right with their descriptions.

_______ a. Pits and deposits on the friction surface of the rotor

_______ b. Shallow scratches in the surface of the rotor

_______ c. Fine cracks in the surface of the rotor

_______ d. Distance between the friction surfaces is not even

_______ e. Tempered areas of metal that become visible when the disc is machined or overheated; may appear as blue discoloration

_______ f. Distance between the friction surfaces is too small

_______ g. Rotor does not run perpendicular to its axle

_______ h. Condition in which one or both sides of the rotor angle away from perpendicular to the axis

1. Cracking
2. Excessive runout
3. Grooving
4. Hard spotting
5. Heat checking
6. Inadequate thickness
7. Lack of parallelism
8. Surface roughness
9. Taper

## Written Test

8. Describe the methods of assembling brake pads.

   a. Bonding

   ______________________________

   ______________________________

   b. Riveting

   ______________________________

   ______________________________

9. Match brake pad defects on the right with their descriptions.

   _______ a. Scratches, gouges, or scoring in the pad

   _______ b. Condition of the lining coming off the pad or the material of the lining separating from itself

   _______ c. Condition in which the wear of the pad is uneven or the wear of the two pads is not equal

   _______ d. Condition in which the pad is worn at an angle from a high spot to a low spot, either side-to-side or end-to-end

   _______ e. Oil, grease, or other substances have penetrated the lining

   _______ f. Thickness of lining is less than manufacturer's recommendations

   1. Excessive wear
   2. Grooving
   3. Pad contamination
   4. Pad separation
   5. Tapered wear
   6. Unequal wear

10. Describe the methods of determining wear on brake pads.

    a. Audible signs— ______________________________

    ______________________________

    b. Visual signs— ______________________________

    ______________________________

11. Describe the functions of noise suppressants and hardware components of a brake pad.

    a. Noise suppressants— ______________________________

    ______________________________

    b. Locator clips— ______________________________

    ______________________________

    c. Antirattle clips— ______________________________

    ______________________________

## Written Test

12. Distinguish between correct and incorrect safety guidelines for disc brake service by placing a "C" next to correct guidelines and an "I" next to incorrect guidelines.

________ a. Always follow manufacturer's procedures and specifications.

________ b. Be sure to keep the parts correctly oriented and installed correctly.

________ c. Perform all service operations on an oiled bench.

________ d. Calipers should hang by the hydraulic brake line.

________ e. Use care not to contaminate the linings with grease, oil, or hydraulic fluid. Replace any linings contaminated with these fluids.

________ f. Avoid getting contaminants on the surface of the rotor. Clean off immediately if fluids are spilled onto it.

________ g. Always reuse old bushings, springs, cotter pins, and other small hardware parts.

________ h. Do not reuse brake system fluids.

________ i. Be sure to mix power steering fluid with hydraulic brake fluid.

________ j. Clean brake parts with any cleaning solution you have in the shop.

________ k. If a rotor must be resurfaced, resurface the other rotors on the same axle to try to maintain them at approximately the same thickness.

________ l. Do not move the vehicle until a firm brake pedal is obtained.

Permission to duplicate this test is granted.

# Hydraulic Foundation Disc Brakes
# Unit 2-B

## Answers to Written Test

1. a. 3
   b. 2
   c. 5
   d. 1
   e. 4

2. a. 2 d. 1 g. 9
   b. 5 e. 6 h. 7
   c. 4 f. 8 i. 3

3. a. 2 e. 6
   b. 7 f. 8
   c. 4 g. 1
   d. 3 h. 5

4. a Boot
   b. Piston
   c. Caliper housing
   d. Inner pad shoe and lining
   e. Outer pad shoe and lining

5. a. 6 d. 1
   b. 3 e. 5
   c. 4 f. 2

6. Answers should include the following in student's own words:
   a. Classification by installation method
      1) Floating—Caliper is mounted on bolts through rubber bushings
      2) Sliding—Caliper is mounted in machined grooves that allow it to move from side to side in the caliper support
   b. Classified by piston count
      1) Single-piston—One piston pushes the pad against the rotor
      2) Double- (or dual-) piston—Two pistons push the pad(s) against the rotor

7. a. 8 e. 4
   b. 3 f. 6
   c. 5 g. 2
   d. 7 h. 9

8. a. Bonding—Use of glues or other adhesives to hold the lining to the pad
   b. Riveting—Use of rivets to hold the lining to the pad

9. a. 2 d. 5
   b. 4 e. 3
   c. 6 f. 1

10. a. Audible signs—Listen for squeal when metal tab on pad contacts the rotor
    b. Visual signs—Look for apparent wear and defects and measure thickness of pads

## Answers to Written Test

11. a. Noise suppressants—Reduce vibration and rattling of brake assembly components
    b. Locator clips—Position parts relative to each other where excessive pressures are not present
    c. Antirattle clips—Reduce vibration and rattling of parts

12. a. C
    b. C
    c. I
    d. I
    e. C
    f. C
    g. I
    h. C
    i. I
    j. I
    k. C
    l. C

# Hydraulic Foundation Disc Brakes
## Unit 2-B

### Unit Evaluation Form

Student Name ______________________________ Unit Rating ____________

Job Sheet 1—Remove, Clean, and Inspect a Caliper and Pad Assembly Rating ______

Comments: ______________________________________________________

______________________________________________________________

Job Sheet 2—Inspect, Measure, Remove, and Reinstall a Rotor Assembly Rating ______

Comments: ______________________________________________________

______________________________________________________________

Job Sheet 3—Reinstall Caliper and Pad Assembly
and Check Brake Operation Rating ______

Comments: ______________________________________________________

______________________________________________________________

**Written Test Scores**

Pretest ________ Posttest ________ Other ________

Other __________________________________________________________

______________________________________________________________

**Teacher Signature** ______________________________ Date ____________

**Student Signature** ______________________________ Date ____________

Permission to duplicate this form is granted.

# Hydraulic System
# Unit 3-B

## Unit Contents

**Teacher Components** **Teacher Page**

1. Suggested Activities
    a. Instructional Plan .....1
    b. Teaching Suggestions .....2
    c. Resources Used in Developing This Unit .....2
    d. Suggested Supplemental Resources .....2
    e. Instructions for Evaluating Student Performance .....3
2. Transparency Masters
    1—Components of a Hydraulic System .....5
    2—Parts of a Brake Pedal .....7
    3—Parts of a Combination Brake Valve .....9
    4—Parts of a Master Cylinder .....11
    5—Types of Wheel Cylinders .....13
3. Answers to Assignment Sheets .....15
4. Written Test .....17
5. Answers to Written Test .....25
6. Unit Evaluation Form .....27

**Student Components** **Student Page**

DT:B

1. Objective Sheet .....B-43
2. Information Sheet .....B-45
3. Assignment Sheets
    1—Interpret Hydraulic System Diagrams .....B-53
    2—Interpret Brake Light System Circuit Diagrams .....B-57
4. Job Sheets
    1—Test Hydraulic System and Inspect for Leaks; Determine Needed Repairs .....B-61
    2—Bleed and/or Flush the Hydraulic Brake System .....B-65
    3—Remove, Inspect, and Repair or Replace the Hydraulic Brake Valve .....B-69
    4—Remove, Inspect, and Repair or Replace the Master Cylinder .....B-73

## Unit Contents

Job Sheets (continued)

5—Create Flare and Double Flare Fittings .B-79
6—Remove and Repair or Replace the Wheel Cylinder .B-83
7—Check and Adjust the Parking Brake .B-87
8—Check Operation of Brake Light Switch; Adjust or Replace as Needed .B-91

# Hydraulic System
# Unit 3-B

## Suggested Activities

### Instructional Plan

### Preparation

1. Read the unit carefully and plan for instruction.

2. Review "Teaching Suggestions." Plan for classroom activities.

3. Plan for students with special needs.

4. Obtain videotapes, service manuals, and other resources to supplement instruction of this unit. See "Resources" for more information.

5. Make transparencies from the transparency masters included in this unit.

6. Develop teaching plan. Adjust for different learning styles.

7. Review "Instructions for Evaluating Student Performance."

8. Make copies of the Unit Evaluation Form, one for each student.

### Delivery and Application

9. Provide students with unit of instruction.

10. Discuss unit and specific objectives.

11. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.

12. Discuss the assignment sheets. Review criteria for evaluation of these activities.

13. Discuss and demonstrate the job sheets. Make sure all required tools, equipment, and supplies are available. Review criteria for evaluation of these activities.

### Evaluation

14. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.

15. Make copies of the written test. Add or modify test items as needed.

16. Give written test.

17. Compile assignment sheet ratings, job sheet ratings, and written test scores on the Unit Evaluation Form. Add any additional assignments or supplemental activities that should be part of the unit evaluation.

18. Reteach and retest as required.

## Suggested Activities

### Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A Report for America 2000* and *Workplace Basics: The Skills Employers Want.* These have been adapted by MAVCC.

1. Have students identify the components of a hydraulic system and their parts using a vehicle so equipped in the shop and/or disassembled parts. **(Information—Acquisition; Systems—Interrelationships)**
2. Show examples of brake valve defects and discuss their causes. **(Basic Skills—Listening; Thinking Skills—Problem solving, reasoning)**
3. Demonstrate and discuss the preventive maintenance required to keep hydraulic systems at optimal levels. Discuss the cost for replacing parts and the importance of failure analysis. **(Thinking Skills—Problem solving; Resources—Time and money; Technology—Maintenance and troubleshooting)**
4. Obtain from manufacturers up-to-date service manuals and troubleshooting guides. Provide these to students so that they may study the resources available to them when working on specific hydraulic systems. **(Basic Skills—Reading; Thinking Skills—Knowing how to learn; Technology—Application and troubleshooting)**
5. Demonstrate and discuss how to read and interpret hydraulic systems diagrams and brake light system circuit diagrams. **(Basic Skills—Reading; Thinking Skills—Seeing things in the mind's eye, problem solving, and reasoning)**
6. Discuss safety precautions to follow when working on the hydraulic system. Point out previous problems that could have been prevented if students had observed the rules. **(Personal Management Skills—Responsibility and organizational effectiveness [value of safety])**

### Resources Used in Developing This Unit

1. *Brakes Specialist.* Stillwater, OK: Curriculum and Instructional Materials Center/Oklahoma Department of Vocational and Technical Education, 1993.
2. *Ford Medium Truck Hydraulic Brakes.* Detroit, MI: Ford Parts and Service Division, Training and Publications Department, 1987.
3. *Grey-Rock Heavy Duty Brake Service Manual.* Owosso, MI: Grey-Rock, 1983.
4. Norman, Ian Andrew et al. *Heavy Duty Truck Systems,* 2nd ed. Albany, NY: Delmar Publishers, Inc., 1996.
5. Schultz, Erich J. *Diesel Equipment I: Lubrication, Hydraulics, Brakes, Wheels, Tires.* Lake Forest, IL: Glencoe Division of Macmillan/McGraw-Hill Publishing Company, 1991.

### Suggested Supplemental Resources

1. FDM700 Hydraulic System Service Manual, 22-201.

Available from your local Mack Truck service center or contact:

Mack Trucks, Inc.
2100 Mack Boulevard
P.O. Box M
Allentown, PA 18105-5000
1-610-439-3011

## Suggested Activities

2. Fluid Power System Components video (GA-031068-V).
3. *Hydraulics Explained: Principles and Fluids, Unit 1*, 18-minute video.
4. *Hydraulics Explained: Actuators, Unit 2*, 19-minute video.
5. *Hydraulics Explained: Controls, Unit 3*, 10-minute video.
6. *Hydraulics Explained: Pumps and Power Units, Unit 4*, 17-minute video.

2-6 are available as 4 videos or 2 CDs from:

National Innovative Media Company (NIMCO)
P.O. Box 9
102 Hwy. 81 North
Calhoun, KY 42327
1-800-962-6662 or fax 1-502-273-5844

### Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

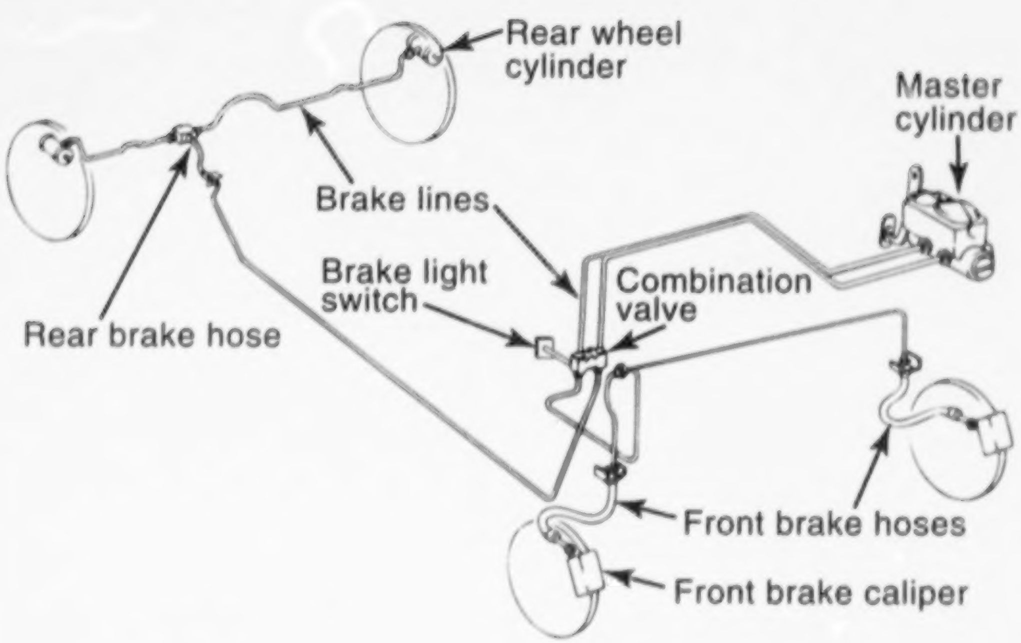
4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

Option B

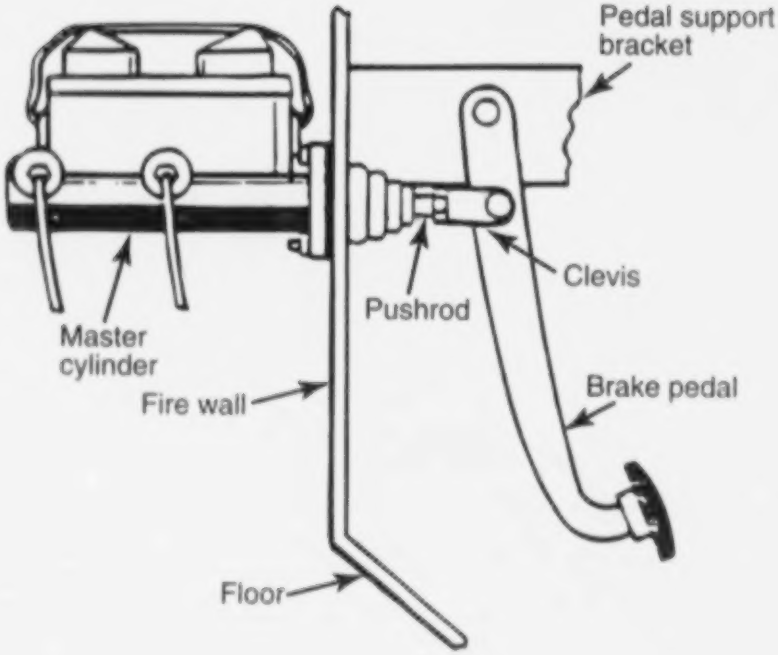
Yes—Can perform job with no additional training.

No—Is unable to perform job satisfactorily.

# Components of a Hydraulic System


Rear wheel cylinder
Master cylinder
Brake lines
Brake light switch
Combination valve
Rear brake hose
Front brake hoses
Front brake caliper

# Parts of a Brake Pedal

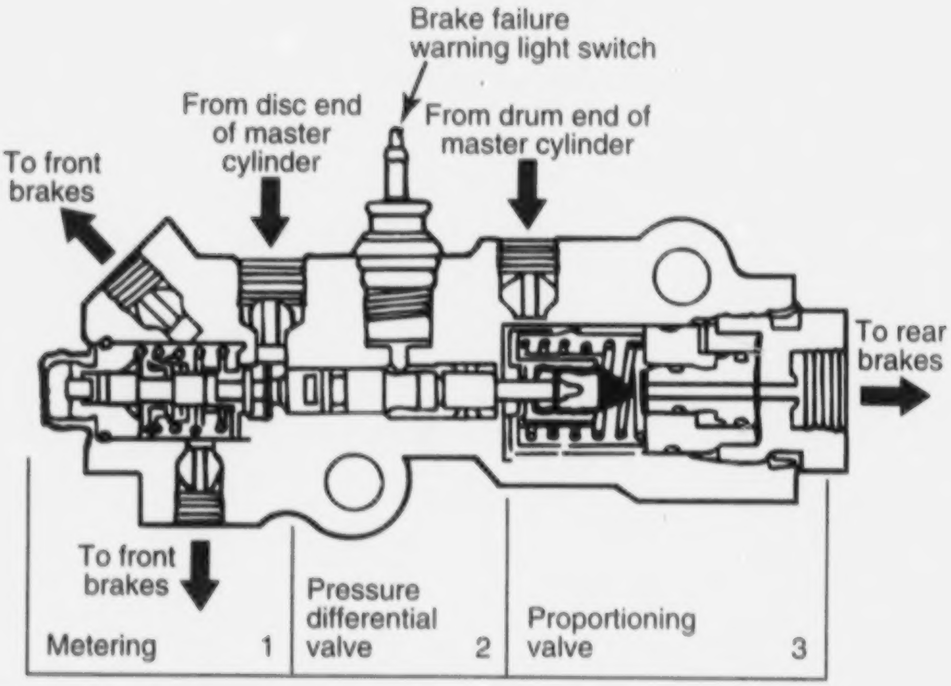


Pedal support bracket
Clevis
Pushrod
Master cylinder
Fire wall
Brake pedal
Floor

Courtesy of RDT

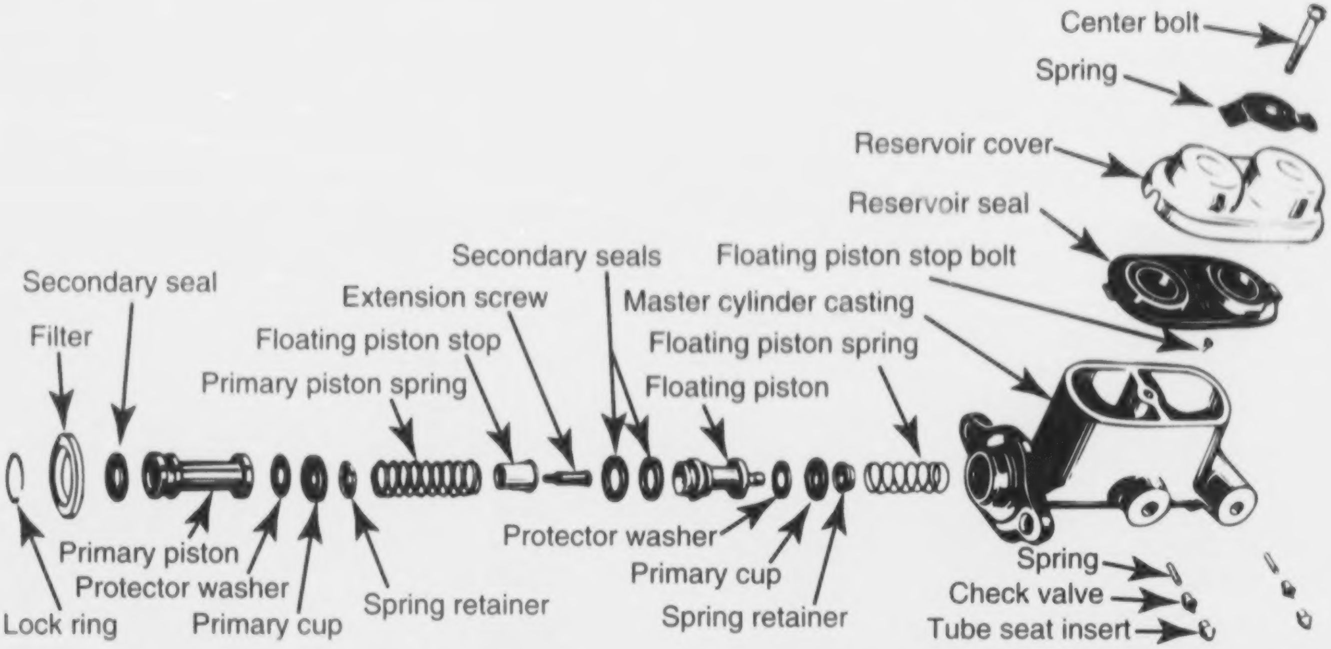
TM 2

# Parts of a Combination Brake Valve


Brake failure warning light switch
From disc end of master cylinder
From drum end of master cylinder
To front brakes
To rear brakes
To front brakes
Metering
1
Pressure differential valve
2
Proportioning valve
3

From *Automotive Brake Service, Unit 3:* Rear Drum Brake and Hydraulic System Service © 1981 by State of Florida, Department of State. Used with permission of State of Florida, Department of State.

# Parts of a Master Cylinder

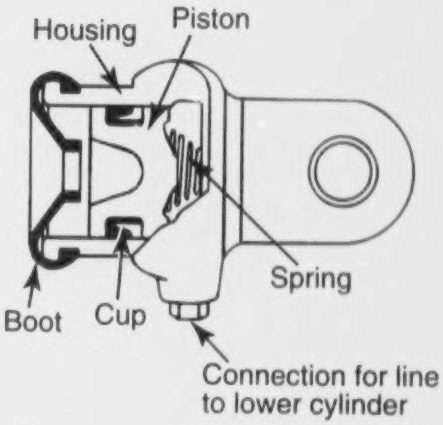

Center bolt
Spring
Reservoir cover
Reservoir seal
Secondary seals
Floating piston stop bolt
Secondary seal
Extension screw
Master cylinder casting
Filter
Floating piston stop
Floating piston spring
Primary piston spring
Floating piston
Primary piston
Protector washer
Lock ring
Primary cup
Spring retainer
Protector washer
Primary cup
Spring retainer
Spring
Check valve
Tube seat insert

Courtesy of Haldex Midland Services

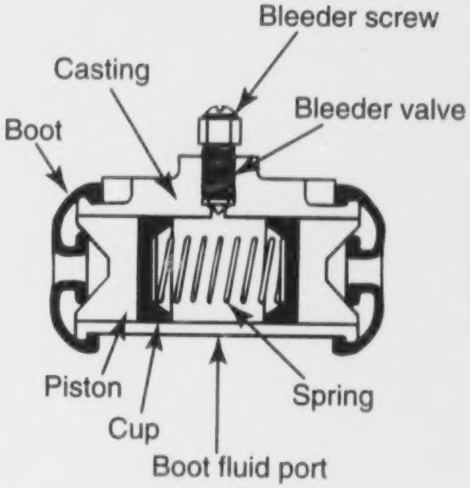
151

152

# Types of Wheel Cylinders


Housing
Piston
Spring
Boot
Cup
Connection for line to lower cylinder

Single Piston


Bleeder screw
Casting
Bleeder valve
Boot
Piston
Spring
Cup
Boot fluid port

Double Piston

Courtesy of Haldex Midland Services

TM 5

# Hydraulic System
# Unit 3-B

## Answers to Assignment Sheets

### Answers to Assignment Sheet 1

1. a. Drum
   b. Primary
   c. Mechanically operated
   d. Push rod
   e. No

2. a. 1
   b. Hydraulically operated
   c. Master cylinder
   d. Brake caliper
   e. Hose is more flexible than steel tubing. This allows for movement of the suspension system in the axle, without the hydraulic line breaking.

### Answers to Assignment Sheet 2

1. a. Mechanical
   b. 10 amp
   c. No
   d. Yes
   e. Ground

2. a. Depressing the brake pedal
   b. Light blue (LT BLU)
   c. 20 amp
   d. Orange (ORN)
   e. 1C11

# Hydraulic System
# Unit 3-B

## Written Test

Name ______________________ Date ____________ Score ____________

1. Match the terms on the right with the correct definitions.

_______ a. Process of controlling the rate of flow of a substance through holes

_______ b. Process of removing the fluid in a hydraulic brake system in order to remove contaminants in the fluid

_______ c. To spread the end of a metal tube so that a connector can be installed

_______ d. Device used to meter or proportion the fluid pressure or flow in a hydraulic system

_______ e. Section of an assembly designed to store a liquid

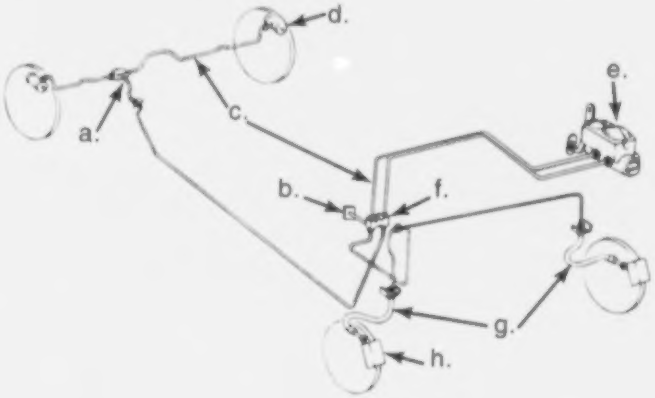
_______ f. Pertaining to a system in which force is transmitted by means of a liquid

_______ g. Process of removing air from the hydraulic brake system

_______ h. Bend in tubing in which the inside diameter of the tubing does not remain uniformly curved

1. Bleeding
2. Flare
3. Flushing
4. Hydraulic
5. Kink
6. Metering
7. Reservoir
8. Split
9. Valve

2. Label the components of a hydraulic system.



a. ______________________ b. ______________________

c. ______________________ d. ______________________

e. ______________________ f. ______________________

g. ______________________ h. ______________________

## Written Test

3. Match the components of a hydraulic system on the right with their functions.

_______ a. Route brake fluid between master cylinder and wheel cylinders

_______ b. Meters and proportions fluid pressure through the system

_______ c. Transfers the force of the brake pedal to engage the brakes against the braking surface

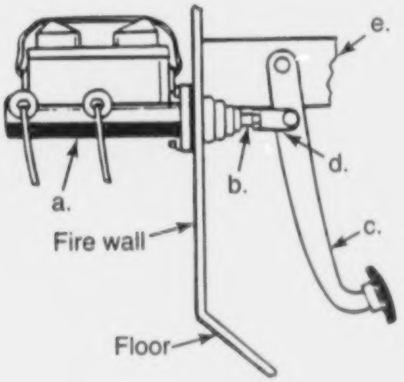
_______ d. Transfers force from the vehicle operator to the brake hydraulic system

_______ e. Turns brake lights on as operator applies brake

_______ f. Stores brake fluid and transfers force from the brake pedal to the wheel cylinders

1. Brake hoses and lines
2. Brake light switch
3. Brake pedal
4. Combination brake valve
5. Master cylinder
6. Wheel cylinder

4. Identify the following parts of a brake pedal.



Courtesy of RDT

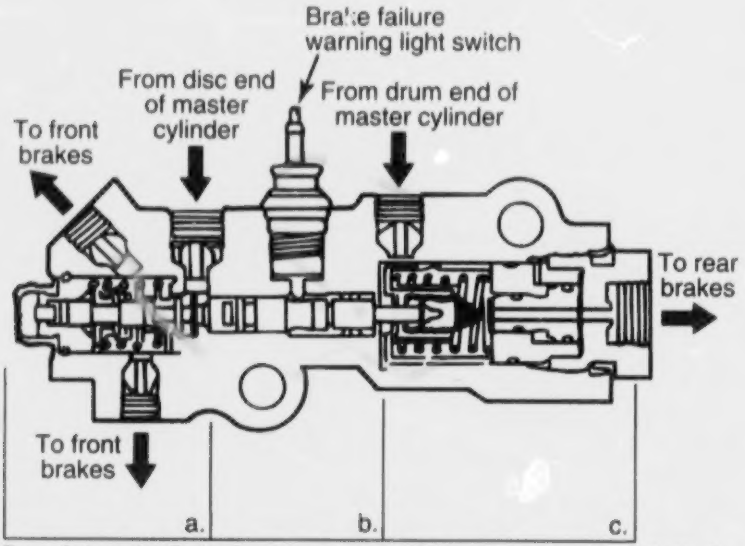
a. ______________________ b. ______________________

c. ______________________ d. ______________________

e. ______________________

## Written Test

5. Identify the following parts of a combination brake valve.


Brake failure warning light switch
From disc end of master cylinder
From drum end of master cylinder
To front brakes
To rear brakes
To front brakes
a.
b.
c.

From *Automotive Brake Service, Unit 3:* Rear Drum Brake and Hydraulic System Service © 1981 by State of Florida, Department of State. Used with permission of State of Florida, Department of State.

a. ______________________________

b. ______________________________

c. ______________________________

6. Match the parts of a combination brake valve on the right with their functions.

| | | |
|---|---|---|
| _______ a. Reduces pressure to the rear wheels during hard braking | | 1. Metering valve |
| _______ b. Monitors for differences in system hydraulic pressure as an indication of brake failure | | 2. Pressure differential valve |
| _______ c. Ensures that the front and rear brakes are applied at the same time | | 3. Proportioning valve |

7. Match brake valve defects on the right with their descriptions.

_____ a. Malfunctions that result from springs that do not provide adequate pressure or that are broken, misaligned, or deformed

_____ b. Brake fluid leaks from the valve through cracks in the housing, loose or defective fittings, or bad seals

_____ c. Brake fluid leaks past pistons and seals so that valve does not hold pressure

_____ d. Parts that do not move as required due to corrosion, misalignment from wear, or deformity from overheating

_____ e. Poor hydraulic response due to air, water, or other contaminants in the brake fluid

1. Broken or worn springs
2. Contamination of fluid
3. External leak
4. Frozen parts
5. Internal leak

8. Match methods of bleeding the hydraulic system on the right with their descriptions.

_____ a. Bleeding of a single component of the brake system while it is removed from the system

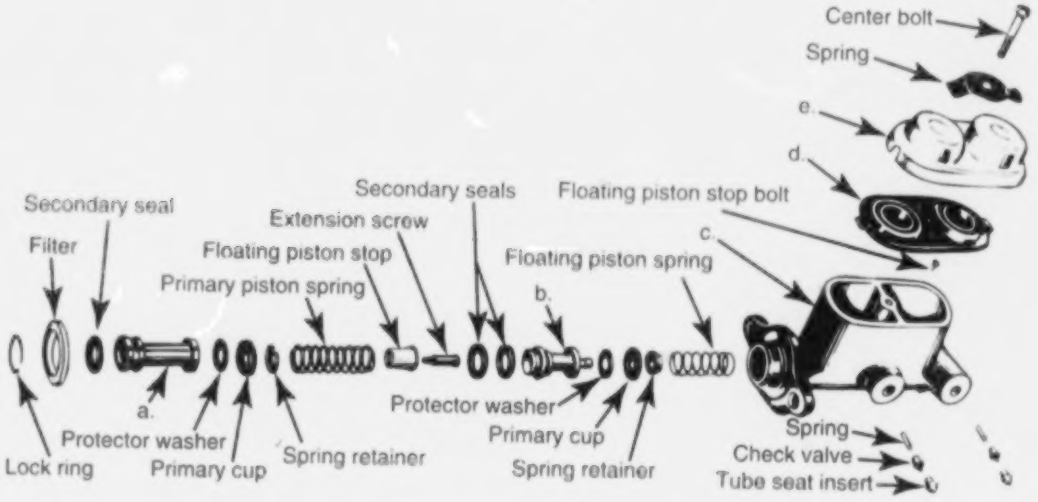
_____ b. Use of a device that provides brake fluid under pressure so that the system can be bled without operating the system components

_____ c. Brake fluid is added to part of the brake system and drained from it until there is no longer evidence of air in the form of bubbles in the air

1. Bench bleeding
2. Manual bleeding
3. Pressure bleeding

## Written Test

9. Identify the following parts of a master cylinder.


Center bolt
Spring
e.
d.
Secondary seals
Floating piston stop bolt
Secondary seal
Extension screw
c.
Filter
Floating piston stop
Floating piston spring
Primary piston spring
b.
a.
Protector washer
Protector washer
Primary cup
Lock ring
Primary cup
Spring retainer
Spring retainer
Spring
Check valve
Tube seat insert

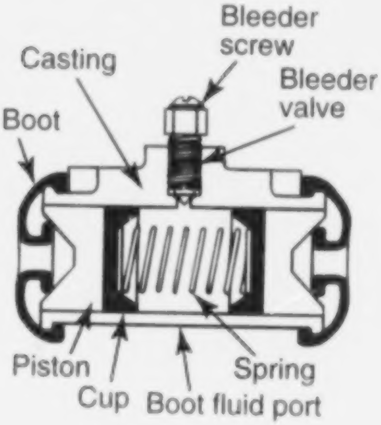
Courtesy of Haldex Midland Services

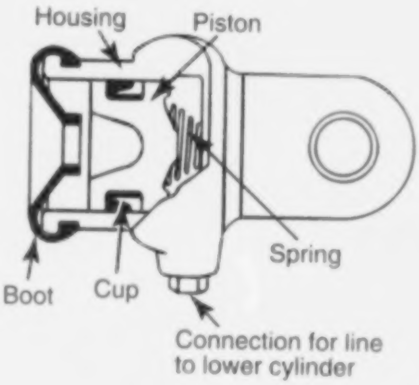
a. ______________________ b. ______________________

c. ______________________ d. ______________________

e. ______________________

10. Distinguish between the types of wheel cylinders by placing an "X" under the illustration of a single piston.


Bleeder screw
Casting
Bleeder valve
Boot
Piston
Spring
Cup
Boot fluid port


Housing
Piston
Spring
Boot
Cup
Connection for line to lower cylinder

Courtesy of Haldex Midland Services

__________ a.

__________ b.

## Written Test

11. Distinguish between the types of brake lines by placing an "S" next to the descriptions of steel tubing and an "H" next to the descriptions of hoses.

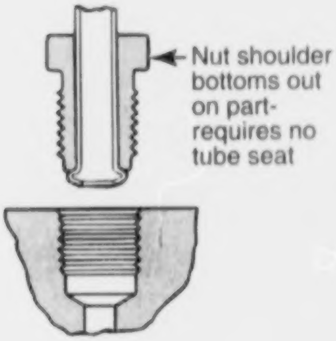
_______ a. Hollow brake line made of bendable steel that has been coated to reduce rust and corrosion

_______ b. Must be purchased from the original equipment manufacturer (OEM) at specified lengths; ends are not replaceable.

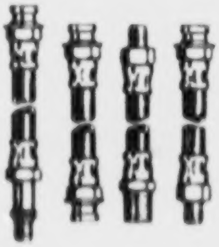
_______ c. Lengths can be adjusted as needed with tubing cutter and flaring tools.

_______ d. Hollow brake line made of alternating layers of flexible rubber and fabric with threaded metal fittings at each end

12. Identify the following types of brake line connections.

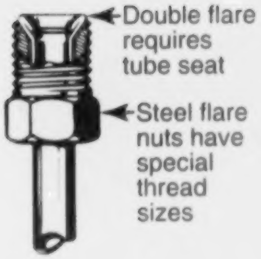

Nut shoulder bottoms out on part-requires no tube seat

a. ______________________________



b. ______________________________

Courtesy of Federal-Mogul Corporation


Double flare requires tube seat
Steel flare nuts have special thread sizes

c. ______________________________

13. Distinguish between the types of parking brakes by placing an "M" next to the description of manual parking brakes and an "H" next to the description of hydraulic brakes.

_______ a. Driveline or rear transmission operated by lever and cable

_______ b. Uses hydraulic pressure to release mechanical spring brake or wedge type spring brake that is hydraulically released

## Written Test

14. Describe switch operation for brake lights and brake failure warning lights.

    a. Brake light switches

        1) Hydraulic switch systems

        ______________________________

        ______________________________

        ______________________________

        2) Mechanical switch systems

        ______________________________

        ______________________________

        ______________________________

    b. Brake failure warning light switches

        ______________________________

        ______________________________

        ______________________________

        ______________________________

        ______________________________

        ______________________________

        ______________________________

Permission to duplicate this test is granted.

# Hydraulic System
# Unit 3-B

## Answers to Written Test

1. a. 6
   b. 3
   c. 2
   d. 9
   e. 7
   f. 4
   g. 1
   h. 5

2. a. Rear brake hose
   b. Brake light switch
   c. Brake lines
   d. Rear wheel cylinder
   e. Master cylinder
   f. Combination valve
   g. Front brake hoses
   h. Front brake caliper

3. a. 1
   b. 4
   c. 6
   d. 3
   e. 2
   f. 5

4. a Master cylinder
   b. Push rod
   c. Brake pedal
   d. Clevis
   e. Pedal support bracket

5. a. Metering valve
   b. Pressure differential valve
   c. Proportioning valve

6. a. 3
   b. 2
   c. 1

7. a. 1
   b. 3
   c. 5
   d. 4
   e. 2

8. a. 1
   b. 3
   c. 2

9. a. Primary piston
   b. Floating piston
   c. Master cylinder casting
   d. Reservoir seal
   e. Reservoir cover

10. b

## Answers to Written Test

11. a. S
    b. H
    c. S
    d. H

12. a. ISO flare fitting for steel tubing
    b. For hose and end fittings
    c. Double flare fitting for steel tubing

13. a. M
    b. H

14. Answers should include the following in student's own words:
    a. Brake light switches
        1) Hydraulic switch systems
            a) Movement of the hydraulic fluid in the master cylinder bore expands a diaphragm in the switch.
            b) The diaphragm closes the contacts inside the switch to complete the circuit.
            c) With the circuit complete, electricity from the battery flows to the brake lights and illuminates them.
            d) When the brakes are released, the pressure on the diaphragm is removed and the contacts open.
        2) Mechanical switch systems
            a) Movement of the brake pedal depresses a spring-loaded switch in the switch unit.
            b) The switch closes the contacts inside the switch assembly to complete the circuit.
            c) With the circuit complete, electricity from the battery flows to the brake lights and illuminates them.
            d) When the brake pedal is released, the spring returns the switch to the open position.
    b. Brake failure warning light switches—Used to indicate a brake system failure
        1) When the brakes are applied, hydraulic fluid is forced through the system, including the pressure differential valve.
        2) The fluid is split between two of the halves of the system with fluid flowing on each side of the pressure differential valve.
        3) If the pressure is greater on one side than on the other, the piston between the two fluid passages will cause the piston to shift away from the higher pressure.
        4) The shifting of the piston pushes a switch which closes a contact in the warning light circuit.
        5) When the pressure is equalized, the piston may or may not return to its centered position, depending on the design of the valve.

# Hydraulic System
## Unit 3-B

### Unit Evaluation Form

Student Name ____________________ Unit Rating ____________

Assignment Sheet 1—Interpret Hydraulic System Diagrams Rating ______

Comments: ________________________________________

________________________________________

Assignment Sheet 2—Interpret Brake Light System Circuit Diagrams Rating ______

Comments: ________________________________________

________________________________________

Job Sheet 1—Test Hydraulic System and Inspect for Leaks; Determine Needed Repairs Rating ______

Comments: ________________________________________

________________________________________

Job Sheet 2—Bleed and/or Flush the Hydraulic Brake System Rating ______

Comments: ________________________________________

________________________________________

Job Sheet 3—Remove, Inspect, and Repair or Replace the Hydraulic Brake Valve Rating ______

Comments: ________________________________________

________________________________________

Job Sheet 4—Remove, Inspect, and Repair or Replace the Master Cylinder Rating ______

Comments: ________________________________________

________________________________________

Job Sheet 5—Create Flare and Double Flare Fittings Rating ______

Comments: ________________________________________

________________________________________

## Unit Evaluation Form

Job Sheet 6—Remove and Repair or Replace the Wheel Cylinder Rating ________

Comments: ____________________________________________

____________________________________________

Job Sheet 7—Check and Adjust the Parking Brake Rating ________

Comments: ____________________________________________

____________________________________________

Job Sheet 8—Check Operation of Brake Light Switch;
Adjust or Replace as Needed Rating ________

Comments: ____________________________________________

____________________________________________

**Written Test Scores**

Pretest ____________ Posttest ____________ Other ____________

Other ____________________________________________

____________________________________________

**Teacher Signature** ______________________ Date ____________

**Student Signature** ______________________ Date ____________

Permission to duplicate this form is granted.

# Power Assist Units and Related Components
# Unit 4-B

## Unit Contents

**Teacher Components** **Teacher Page**

1. Suggested Activities

   a. Instructional Plan .................... 1
   b. Teaching Suggestions .................... 2
   c. Resources Used in Developing This Unit .................... 2
   d. Instructions for Evaluating Student Performance .................... 3

2. Transparency Masters

   1—Parts of a Vacuum Power Assist Unit .................... 5
   2—Parts of a Hydraulic Power Assist Unit and Electrical Components .................... 7

3. Written Test .................... 9

4. Answers to Written Test .................... 15

5. Unit Evaluation Form .................... 17

**Student Components** **Student Page**

DT:B

1. Objective Sheet .................... B-95

2. Information Sheet .................... B-97

3. Job Sheets

   1—Inspect and Test the Power Assist System and Emergency Brake Back-Up System; Determine Needed Repairs .................... B-103
   2—Remove, Inspect, and Repair or Replace the Power Assist Unit .................... B-107
   3—Check Operation of Brake Failure Lights and Braking Warning Devices; Repair or Replace as Needed .................... B-111

# Power Assist Units and Related Components
## Unit 4-B

### Suggested Activities

### Instructional Plan

**Preparation**

1. Read the unit carefully and plan for instruction.
2. Review "Teaching Suggestions." Plan for classroom activities.
3. Plan for students with special needs.
4. Obtain videotapes, service manuals, and other resources to supplement instruction of this unit. See "Resources" for more information.
5. Make transparencies from the transparency masters included in this unit.
6. Develop teaching plan. Adjust for different learning styles.
7. Review "Instructions for Evaluating Student Performance."
8. Make copies of the Unit Evaluation Form, one for each student.

**Delivery and Application**

9. Provide students with unit of instruction.
10. Discuss unit and specific objectives.
11. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
12. Discuss and demonstrate the job sheets. Make sure all required tools, equipment, and supplies are available. Review criteria for evaluation of these activities.

**Evaluation**

13. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.
14. Make copies of the written test. Add or modify test items as needed.
15. Give written test.
16. Compile job sheet ratings and written test scores on the Unit Evaluation Form. Add any additional assignments or supplemental activities that should be part of the unit evaluation.
17. Reteach and retest as required.

## Suggested Activities

### Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A Report for America 2000* and *Workplace Basics: The Skills Employers Want*. These have been adapted by MAVCC.

1. Discuss how power assist units work in relationship to the vehicle's braking operation. Explain how a vacuum power assist unit differs from a hydraulic power assist unit. **(Information—Acquisition; Systems—Interrelationships)**

2. Discuss the most common problems that you have encountered with power assist units. Also discuss how these problems affected the operation of the vehicle. **(Thinking Skills—Problem solving; Technology—Maintenance and troubleshooting)**

3. Demonstrate and discuss preventive maintenance procedures for power assist units. Discuss the costs for replacing parts and the importance of failure analysis of faulty parts to prevent costly repairs. **(Thinking Skills—Problem solving; Resources—Time and money; Technology—Maintenance and troubleshooting)**

4. Obtain from manufacturers up-to-date service manuals, bulletins, troubleshooting guides, videos, and brochures that address power assist units. Provide these to students so that they may study the resources available to them when working on specific units. **(Basic Skills—Reading; Thinking Skills—Knowing how to learn; Technology—Application and troubleshooting)**

5. Discuss safety precautions to follow when working on power assist units. Include the proper procedure for handling/disposing of brake fluid and steering fluid and what to do in case fluid is splashed in the eyes. **(Personal Management Skills—Responsibility and organizational effectiveness [value of safety])**

### Resources Used in Developing This Unit

1. *Ford Medium Truck Hydraulic Brakes*. Detroit, MI: Ford Parts and Service Division, Training and Publications Department, 1987.

2. *Grey-Rock Heavy Duty Brake Service Manual*. Owosso, MI: Grey-Rock, 1983.

3. *Hydro-Max Power Brake System*. Detroit, MI: Ford Parts and Service Division, Training and Publications Department, 1986.

4. Norman, Ian Andrew et al. *Heavy Duty Truck Systems*, 2nd ed. Albany, NY: Delmar Publishers, Inc., 1996.

5. Schultz, Erich J. *Diesel Equipment I: Lubrication, Hydraulics, Brakes, Wheels, Tires*. Lake Forest, IL: Glencoe Division of Macmillan/McGraw-Hill Publishing Company, 1991.

## Suggested Activities

### Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

Option B

Yes—Can perform job with no additional training.

No—Is unable to perform job satisfactorily.

# Parts of a Vacuum Power Assist Unit

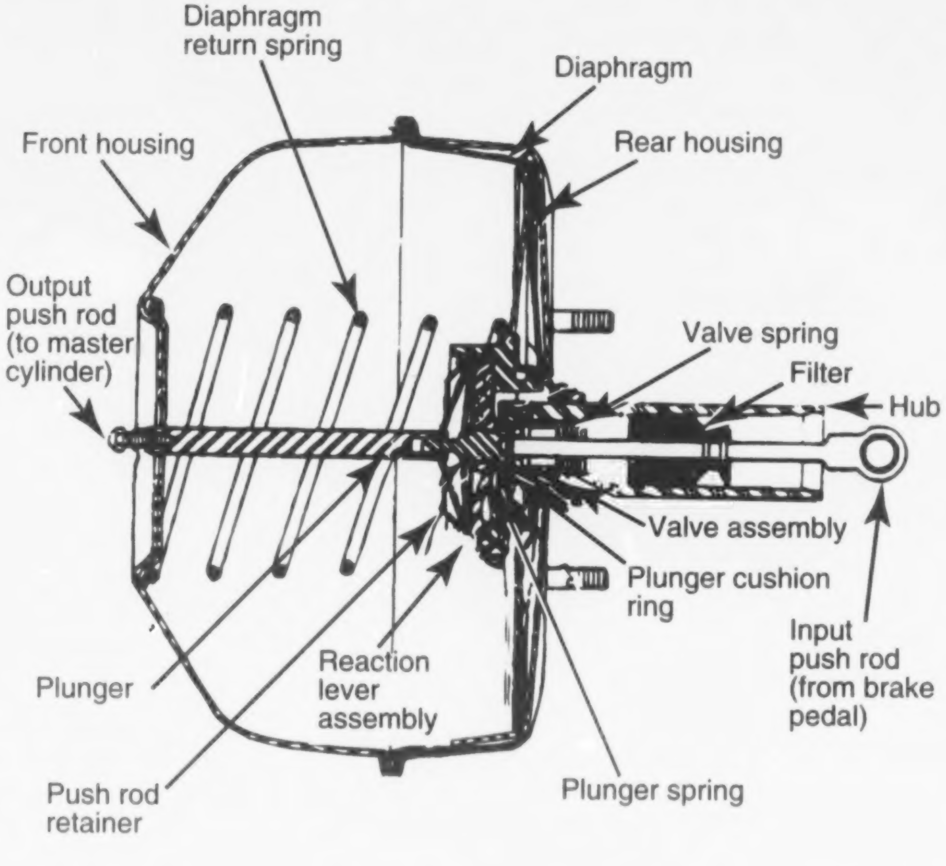

Diaphragm return spring
Diaphragm
Front housing
Rear housing
Output push rod (to master cylinder)
Valve spring
Filter
Hub
Valve assembly
Plunger cushion ring
Input push rod (from brake pedal)
Reaction lever assembly
Plunger
Push rod retainer
Plunger spring

Illustration used with permission of Ford Motor Company

# Parts of a Hydraulic Power Assist Unit and Electrical Components

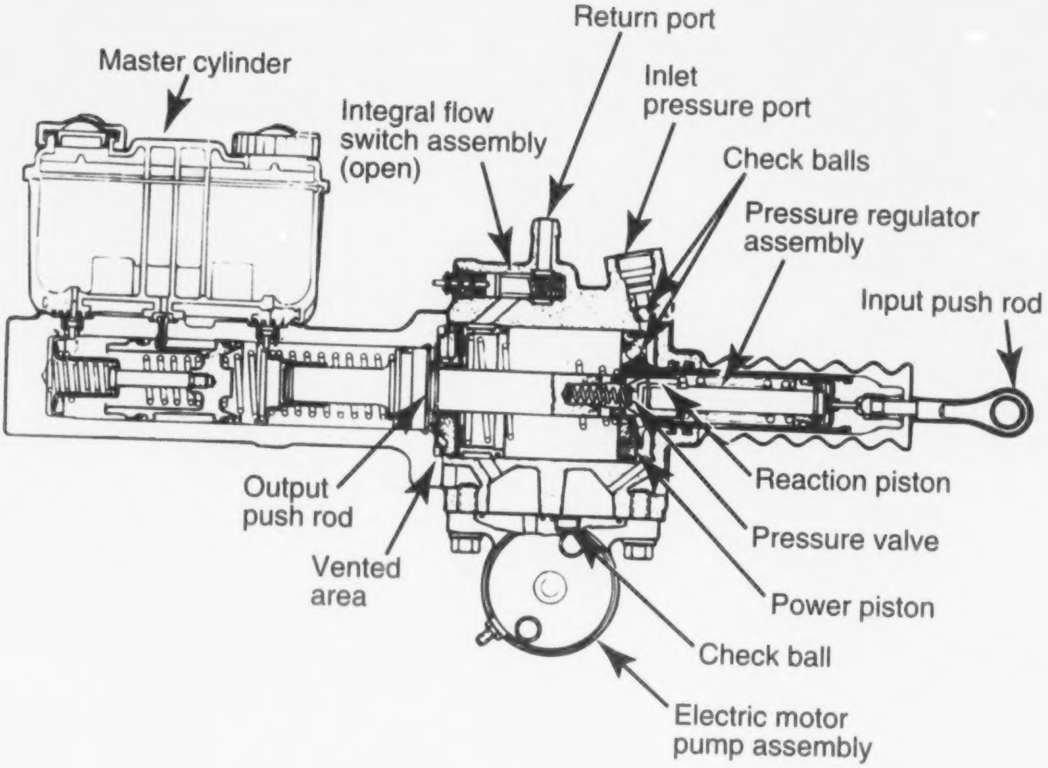

Return port
Master cylinder
Inlet pressure port
Integral flow switch assembly (open)
Check balls
Pressure regulator assembly
Input push rod
Reaction piston
Output push rod
Pressure valve
Vented area
Power piston
Check ball
Electric motor pump assembly

Illustration used with permission of Ford Motor Company

# Power Assist Units and Related Components
## Unit 4-B

### Written Test

Name ____________________________ Date ____________ Score ____________

1. Match the terms on the right with the correct definitions.

______ a. Device used as a booster in a brake system

______ b. Thin, flexible membrane used to separate two areas; flexes in response to changes in air pressure on each side of it

______ c. Device used to store power

______ d. Space without air; usually has different air pressure on each side that creates a force that can be used as an energy source

______ e. Glycol-based substance used to transmit force in hydraulic brake systems

______ f. Petroleum-based substance used in hydraulic pumps

______ g. Consisting of parts arranged one behind the other; usually acting in partnership

______ h. Difference in air pressure from one side to another

1. Accumulator
2. Brake fluid
3. Diaphragm
4. Differential
5. Hydraulic oil
6. Power assist unit
7. Tandem
8. Vacuum

2. State the purpose of a power assist unit.

______________________________________________________

______________________________________________________

3. Distinguish between the basic types of power assist units by placing a "V" next to vacuum power assist units and an "H" next to hydraulic power assist units.

______ a. Created to separate two different air pressures

______ b. Involve an engine-driven hydraulic pump or power steering pump as the energy boost source

______ c. Assist in applying hydraulic force to the master cylinder, thereby increasing brake system effectiveness

______ d. Used primarily on light-duty vehicles and some medium-duty vehicles, especially gasoline-powered

______ e. Used on the majority of medium-duty and heavy-duty vehicles with hydraulic brake systems

4. Identify the following parts of a vacuum power assist unit.

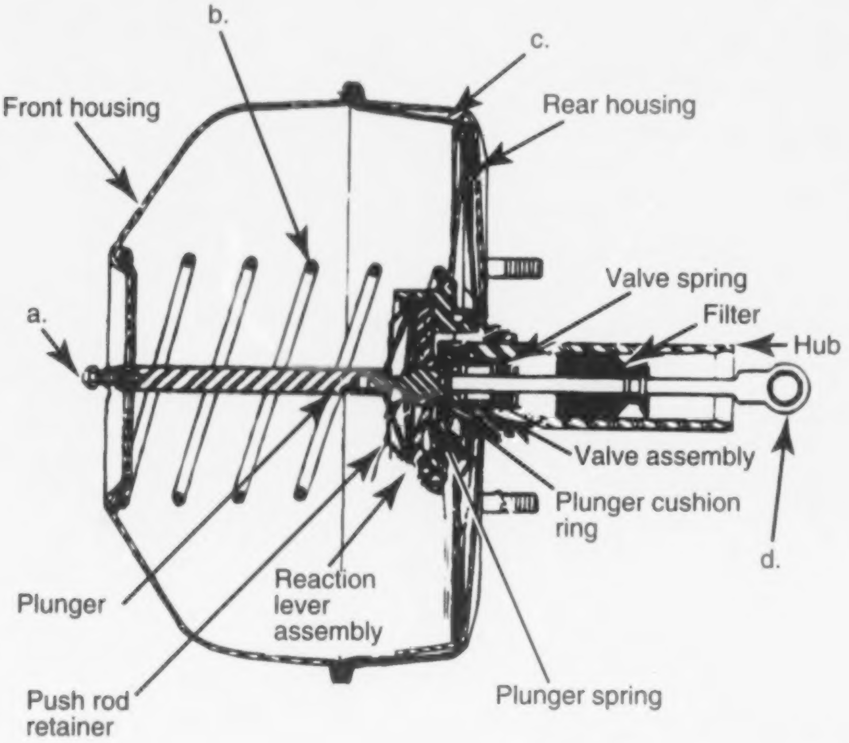

b.
c.
Front housing
Rear housing
Valve spring
Filter
Hub
a.
Valve assembly
Plunger cushion ring
d.
Plunger
Reaction lever assembly
Push rod retainer
Plunger spring

Illustration used with permission of Ford Motor Company

a. ______________________________ b. ______________________________

c. ______________________________ d. ______________________________

## Written Test

5. Identify the following parts of a hydraulic power assist unit and related components.

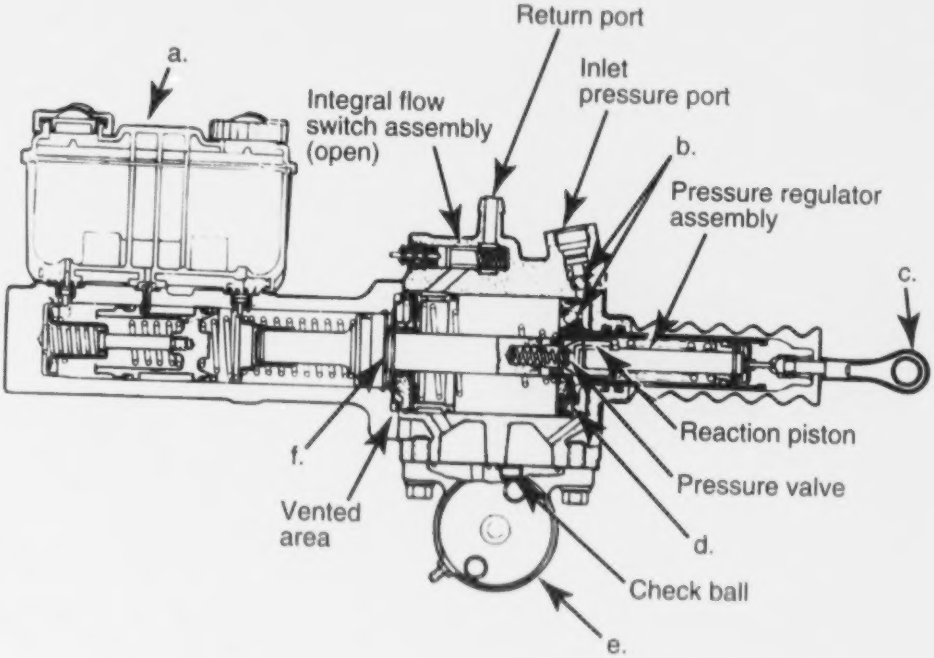

a.
Return port
Inlet pressure port
Integral flow switch assembly (open)
b.
Pressure regulator assembly
c.
Reaction piston
Pressure valve
d.
Check ball
e.
f.
Vented area

Illustration used with permission of Ford Motor Company

a. ______________________ b. ______________________

c. ______________________ d. ______________________

e. ______________________ f. ______________________

## Written Test

6. Match the basic parts of power assist units with their functions.

_______ a. Monitor and regulate energy sources (vacuum or hydraulic) in response to brake pedal application and release

_______ b. Allow for connections of the power assist unit with other brake components or related components

_______ c. Transfers force from brake pedal to booster piston

_______ d. Returns vacuum diaphragm or hydraulic booster (power) piston to normal position when brakes are released

_______ e. Transmits force from booster piston or plunger to master cylinder piston

_______ f. Moves in response to pressure changes and transmits force from input to output push rods

_______ g. Protects components of the power assist unit

1. Booster piston(s) and/or plunger
2. Control valve assemblies
3. Housing
4. Input push rod
5. Output push rod
6. Ports
7. Return spring(s)

7. Describe five of the most common problems associated with power assist units.

a. ________________________________________

b. ________________________________________

c. ________________________________________

d. ________________________________________

e. ________________________________________

8. Complete the following statements concerning the adjustment of the brake booster push rod by circling the correct answers.

a. The output push rod is typically adjusted using the adjustment screw on the (**push rod, master cylinder**).

b. (**Replacement, Adjustment**) is necessary to maintain the correct relationship between the booster control valve plunger and the master cylinder piston.

c. If the push rod is too (**long, short**), it will prevent the master cylinder piston from completely releasing hydraulic pressure, causing brakes to drag.

d. If the push rod is too (**long, short**), it will cause excessive pedal travel and an undesirable clunk in the booster area.

e. The (**master cylinder, booster control valve plunger**) will have to be removed in order to gain access to the brake booster push rod.

f. A height gauge will need to be fabricated according to the manufacturer's specifications to check the correct push rod (**model, length**).

9. Distinguish between the emergency back-up systems by placing an "E" next to electro-hydraulic pumps and an "A" next to accumulators.

_______ a. It is typically used on medium- and heavy-duty vehicles.

_______ b. Normal output pressure is about one-half of the main brake hydraulic pump or power steering pump.

_______ c. It is typically used on light- and medium-duty vehicles.

_______ d. It is usually mounted to the bottom of the booster housing.

_______ e. This device stores force from the power steering pump.

_______ f. It will act as a reserve power source in case of failure from the main hydraulic source.

_______ g. This is typically a vane-type pump that acts as the reserve or back-up power source to provide boost pressure whenever there is no flow through the hydraulic booster system. This would occur when the engine is off or a hose or belt is broken.

10. Complete the following statements concerning the use of brake fluid and power steering fluid on power assist units by circling the correct answers.

a. The master cylinder and the brake system use standard (**petroleum, glycol**) -based brake fluid.

b. The hydraulic power assist unit (booster) and the hydraulic brake pump or power steering pump use (**petroleum, glycol**) -based power steering fluid (hydraulic oil).

c. (**Do, Do not**) mix brake fluid and power steering fluid.

d. If the hydraulic power assist system becomes contaminated, flush with clean (**brake, power steering**) fluid.

e. Always make sure you are replacing fluids with the correct (**type, brand**).

f. (**Do, Do not**) reuse brake system fluids.

g. Store both brake fluid and power steering fluid (**near, away from**) heat or flame.

h. Avoid skin and eye contact with (**brake fluids, both types of fluids**).

Permission to duplicate this test is granted.

# Power Assist Units and Related Components
## Unit 4-B

### Answers to Written Test

1.
    - a. 6
    - b. 3
    - c. 1
    - d. 8
    - e. 2
    - f. 5
    - g. 7
    - h. 4

2. To increase or "boost" the force of the brake pedal, thereby decreasing the braking effort by the vehicle operator

3.
    - a. V
    - b. H
    - c. H
    - d. V
    - e. H

4.
    - a Output push rod (to master cylinder)
    - b. Diaphragm return spring
    - c. Diaphragm
    - d. Input push rod (from brake pedal)

5.
    - a. Master cylinder
    - b. Check balls
    - c. Input push rod
    - d. Power piston
    - e. Electric motor pump assembly
    - f. Output push rod

6.
    - a. 2
    - b. 6
    - c. 4
    - d. 7
    - e. 5
    - f. 1
    - g. 3

7. Any five of the following:
    - a. Hard brake pedal (excessive pedal pressure required to stop)
    - b. Excessive brake pedal travel
    - c. Sluggish application and release
    - d. Grabby brakes (apparent off-on condition)
    - e. Brakes fail to release
    - f. Leaks (vacuum or hydraulic)
    - g. Excessive pump noise (chatter, gurgle, etc.)
    - h. Inoperative pump
    - i. Improper operation of electrical system shown by brake lights, electro-hydraulic/electric pump, and any electrical accessories

8.
    - a. Push rod
    - b. Adjustment
    - c. Long
    - d. Short
    - e. Master cylinder
    - f. Length

## Answers to Written Test

9. a. E
   b. E
   c. A
   d. E
   e. A
   f. A
   g. E

10. a. Glycol
    b. Petroleum
    c. Do not
    d. Power steering
    e. Type
    f. Do not
    g. Away from
    h. Both types of fluids

# Power Assist Units and Related Components
# Unit 4-B

## Unit Evaluation Form

Student Name ______________________ Unit Rating __________

Job Sheet 1—Inspect and Test the Power Assist System and Emergency Brake Back-Up System; Determine Needed Repairs Rating ______

Comments: ______________________

______________________

Job Sheet 2—Remove, Inspect, and Repair or Replace the Power Assist Unit Rating ______

Comments: ______________________

______________________

Job Sheet 3—Check Operation of Brake Failure Lights and Braking Warning Devices; Repair or Replace as Needed Rating ______

Comments: ______________________

______________________

**Written Test Scores**

Pretest ________ Posttest ________ Other ________

Other ______________________

______________________

**Teacher Signature** ______________________ Date __________

**Student Signature** ______________________ Date __________

Permission to duplicate this form is granted.

# Air Foundation Brakes
# Unit 1-C

## Unit Contents

**Teacher Components** **Teacher Page**

1. Suggested Activities
   - a. Instructional Plan .......... 1
   - b. Teaching Suggestions .......... 2
   - c. Resources Used in Developing This Unit .......... 2
   - d. Suggested Supplemental Resources .......... 3
   - e. Instructions for Evaluating Student Performance .......... 6
2. Transparency Masters
   - 1—Air Foundation Brake Components .......... 7
   - 2—Types of Air Foundation Brakes .......... 9
   - 3—Parts of a Cam Foundation Brake .......... 11
   - 4—Parts of a Wedge Foundation Brake .......... 13
   - 5—Parts of a Disc Foundation Brake .......... 15
   - 6—Parts of Slack Adjusters .......... 17
   - 7—Parts of a Service Brake Chamber (Front Axle) .......... 19
3. Written Test .......... 21
4. Answers to Written Test .......... 33
5. Unit Evaluation Form .......... 37

**Student Components** **Student Page**

DT:B

1. Objective Sheet .......... C-1
2. Information Sheet .......... C-3
3. Job Sheets
   - 1—Inspect, Service, and Adjust Slack Adjuster on Front Axle .......... C-19
   - 2—Inspect, Test, Service, and Replace Service Brake Chamber .......... C-25
   - 3—Remove, Inspect, and Replace Brake Shoes, Drum, and Hardware for S-Cam Drum Foundation Brakes .......... C-29
   - 4—Remove, Inspect, and Replace Brake Shoes, Drum, and Hardware for Wedge-Type Drum Foundation Brakes .......... C-35
   - 5—Inspect, Clean, and Measure Brake Calipers, Pads, and Rotors; Replace Pads if Needed .......... C-41

# Air Foundation Brakes
## Unit 1-C

## Suggested Activities

### Instructional Plan

### Preparation

1. Read the unit carefully and plan for instruction.
2. Review "Teaching Suggestions." Plan for classroom activities.
3. Plan for students with special needs.
4. Obtain videotapes, service manuals, and other resources to supplement instruction of this unit. See "Resources" for more information.
5. Make transparencies from the transparency masters included in this unit.
6. Develop teaching plan. Adjust for different learning styles.
7. Review "Instructions for Evaluating Student Performance."
8. Make copies of the Unit Evaluation Form, one for each student.

### Delivery and Application

9. Provide students with unit of instruction.
10. Discuss unit and specific objectives.
11. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
12. Discuss and demonstrate the job sheets. Make sure all required tools, equipment, and supplies are available. Review criteria for evaluation of these activities.

### Evaluation

13. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.
14. Make copies of the written test. Add or modify test items as needed.
15. Give written test.
16. Compile job sheet ratings and written test scores on the Unit Evaluation Form. Add any additional assignments or supplemental activities that should be part of the unit evaluation.
17. Reteach and retest as required.

## Suggested Activities

### Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A Report for America 2000* and *Workplace Basics: The Skills Employers Want*. These have been adapted by MAVCC.

1. Have students identify the basic components of air foundation brakes using disassembled parts. By seeing the actual parts and their relationship to the braking system, the student will be better prepared to complete the job sheets. **(Information—Acquisition; Systems-Interrelationships)**

2. Discuss the most common problems that you have encountered with air foundation brakes. Also discuss how these problems affected the operation of the vehicle. **(Thinking Skills—Problem solving; Technology—Maintenance and troubleshooting)**

3. Have students practice inspecting brake parts for damage. **(Thinking Skills—Problem solving)**

4. Demonstrate and discuss the preventive maintenance required to keep air foundation brakes at optimal levels. Discuss the costs for replacing parts and the importance of failure analysis of faulty parts to prevent further damage to braking system or even to prevent an accident should the brakes fail. **(Thinking Skills—Problem solving; Resources—Time and money; Technology—Maintenance and troubleshooting)**

5. Obtain from manufacturers up-to-date service manuals, bulletins, troubleshooting guides, videos, and brochures that explain air foundation brakes. Provide these to students so that they may study the resources available to them when working on specific brakes. **(Basic Skills—Reading; Thinking Skills—Knowing how to learn; Technology—Application and troubleshooting)**

6. Discuss safety precautions to follow when working on air foundation brakes. Point out previous problems that could have been prevented if students had observed the rules. **(Personal Management Skills—Responsibility and organizational effectiveness [value of safety])**

### Resources Used in Developing This Unit

1. *The Air Brake Book*, 5th revised ed. Radnor, PA: Commercial Carrier Journal.
2. *Air Brake Handbook*. Elyria, OH: AlliedSignal Automotive, Truck Brake Systems Company, 1995.
3. *Air Brake System*. Allentown, PA: Mack Trucks, 1986.
4. *Air Disc Brakes*, Maintenance Manual No. 4M. Troy, MI: Rockwell International, 1992.
5. *Automatic Slack Adjuster*, Maintenance Manual No. 4B. Troy, MI: Rockwell International, 1993.
6. *Automatic Slack Adjuster Service Manual*. Kansas City, MO: Midland Brake, Inc., 1990.
7. *Cam Brakes*, Maintenance Manual No. 4. Troy, MI: Rockwell International, 1992.
8. *Commercial Driver's License (CDL) Driver's Manual, Version 2.0*. AAMVA.
9. *Drum Brake Service Manual*. Galesburg, MI: Eaton Corporation, Brake Division, 1982.

## Resources Used in Developing This Unit (continued)

10. *Grey-Rock Heavy Duty Brake Service Manual.* Owosso, MI: Grey-Rock, 1983.
11. Norman, Ian Andrew et al. *Heavy Duty Truck Systems*, 2nd ed. Albany, NY: Delmar Publishers, Inc., 1996.
12. *Workbook and Learning Aid for Air Brake Systems.* Kansas City, MO: Midland-Grau Heavy Duty Systems, 1991.

## Suggested Supplemental Resources

1. Foundation Brake and Friction Material Troubleshooting, BW1558. VHS training video. Available from:

   AlliedSignal Truck Brake Systems Co.
   901 Cleveland Street
   P.O. Box 4016
   Elyria, OH 44036-2016
   1-216-329-9000

2. Preventive Maintenance Inspection (PMI) Guidelines: Class 7 & 8 Diesel-Powered Tractors with Air Brakes Manual.

3. S-Cam Brake Adjustment, 17-minute videotape that covers manual and automatic slack adjusters, as well as emergency roadside adjustment. English or Spanish versions.

   2 and 3 are available from:

   American Trucking Associations
   Customer Services Department
   2200 Mill Road
   Alexandria, VA 22314-4677
   1-800-ATA-LINE or fax # 1-800-225-8382

4. Medium-Duty Truck Air Brake Systems Manual, (item #P-9338). Provides fundamentals, components, operation, and diagnosis of General Motors air brake systems. 200 pages.

   Available from:

   Automotive Service Association
   P.O. Box 929
   Bedford, TX 76095-0929
   1-817-283-6205, 1-800-272-7467, or fax 1-817-685-0225

5. Heavy-Duty Air Brake Service Manual, (#4412-R).

   Available from:

   Brake Parts Inc.
   (Raybestos)
   1-800-323-0354

6. Off-Highway Trucks—Air System and Brakes, SEGV2595, 74 slides, 1993.

## Suggested Activities

### Suggested Supplemental Resources (continued)

7. Articulated Trucks—Air System and Brakes, SESV1607, 34 slides, 1992.
8. Articulated Trucks—Vehicle Systems and Brakes, SESV1627, 60 slides, 1992.
9. Articulated Trucks—Hydraulic, Brake, and Air Systems, SESV1503, 45 slides, 1985.

   6 through 9 are available from your local CAT dealer or write the following for more information:

   Caterpillar Service Training
   600 W. Washington, St., Bldg. JJ
   East Peoria, IL 61630

10. Air Brake Systems Instruction Manual and Self-Study Guides, #457820.

    Available from:

    CR Services
    735 Tollgate Road
    Elgin, IL 60123-9332
    1-708-742-7840

11. B400T Inspection (Heavy Duty Trucks) videotape, (order #3536-T) Covers use of B400T brake tester to diagnose brake condition.

    Available from:

    Hunter Engineering Company
    Service Center 2531 Metro Boulevard
    Maryland Heights, MO 63043-2411

12. Air Brake System Service Manual, 16.1.
13. CH Model Air Brake System Service Manual, 16-102.

    12 and 13 are available from your local Mack Truck service center or contact:

    Mack Trucks, Inc.
    2100 Mack Boulevard
    P.O. Box M
    Allentown, PA 18105-5000
    1-610-439-3011

14. The "Pure Air" Air Dryer, Part #VL1 video.
15. Midland Spring Brake Benefits, Part #VL2 video.
16. Midland EL 1300/1600 Compressors, Part #VL5 video.
17. Midland Automatic Slack Adjuster, Part #VL27 video.
18. S-Cam Brake Maintenance and Troubleshooting, Part #VL29 video. Discusses foundation brake systems and brake adjustment.

## Suggested Supplemental Resources (continued)

19. The Forgotten Ones, Part #VL32 video. Discusses trailer air system valves and devices.
20. Stopping the Big Rigs, Part #VL35 video. Presents overview of truck/tractor air brake system.

14 through 20 are available from:

Midland-Grau Heavy Duty Systems
10930 N. Pomona Avenue
Kansas City, MO 64153
1-816-891-2470 or fax # 1-816-891-9447

21. Air Brake System, (81-4). GMC Truck film strips transferred to videotape.
22. Foundation Brakes for C/K Models, (88-9). GMC Truck videotape.

21 and 22 are available from:

Regan Productions, Inc.
Service Video Library
19730 Ralston
Detroit, MI 48203
1-313-368-3000

23. Technical instruction booklets
    a. Air Brake Systems Schematic Diagrams, (1 987 722 165)
    b. Air Brake Systems Equipment, (1 987 722 166)
    c. Air Brake Systems Symbols, (1 987 722 167)

Available from:

Robert Bosch Corporation
Training Materials
2740 West 79th Street
Chicago, IL 60652
1-800-937-2672 or fax 1-312-776-1717

24. Rockwell Cam Brake Maintenance, Video-90233
25. Automatic Slack Adjuster Installation and Maintenance, Video-90234
26. Rockwell Air Disc Brake Maintenance, Video-T-92108
27. Q and Q Plus Cam Brakes, Video-T-9262V
28. New Generation Automatic Slack Adjuster, Video-T-9443V

24 through 28 are available from:

Rockwell International Corp.
c/o Vispac, Inc.
35000 Industrial Road
Livonia, MI 48150
1-248-435-8689

## Suggested Activities

### Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

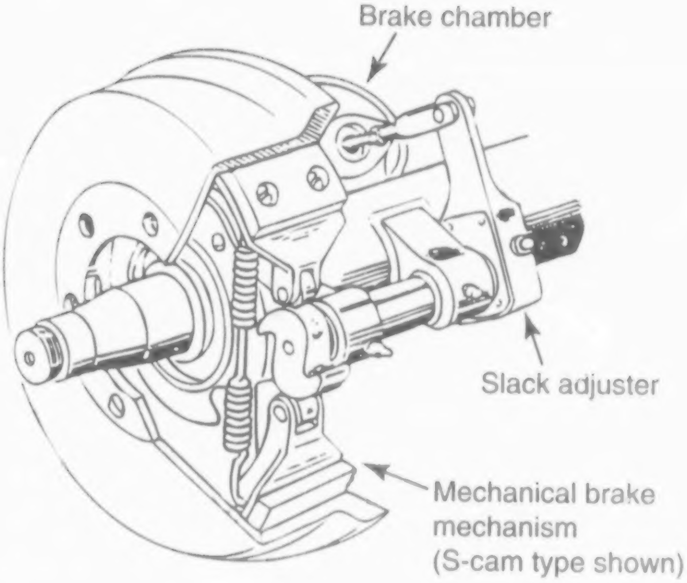
4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

Option B

Yes—Can perform job with no additional training.

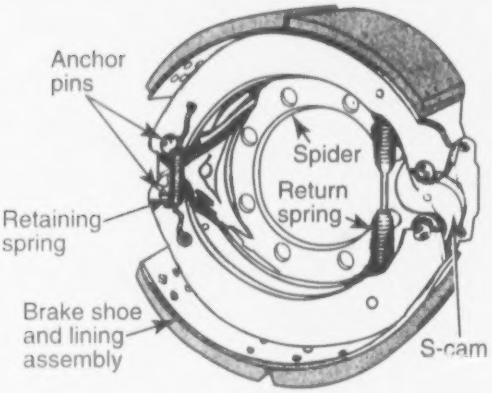
No—Is unable to perform job satisfactorily.

# Air Foundation Brake Components


Brake chamber
Slack adjuster
Mechanical brake mechanism (S-cam type shown)

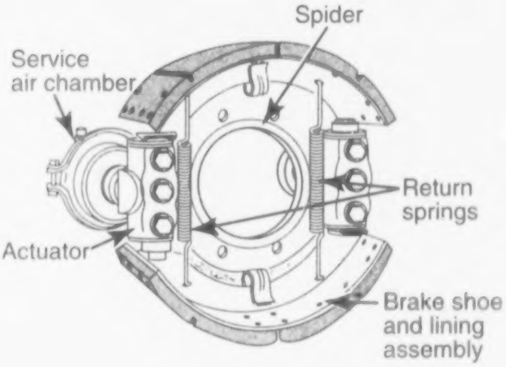
Courtesy of AlliedSignal Bendix

# Types of Air Foundation Brakes


Anchor pins
Spider
Return spring
Retaining spring
Brake shoe and lining assembly
S-cam

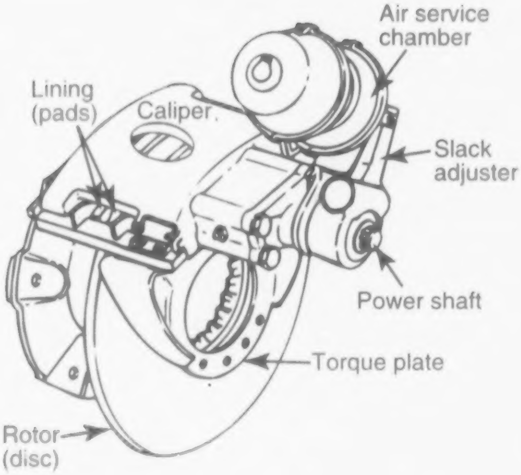
**Cam Brake**

Courtesy of Meritor Automotive, Inc.


Spider
Service air chamber
Return springs
Actuator
Brake shoe and lining assembly

**Wedge Brake**

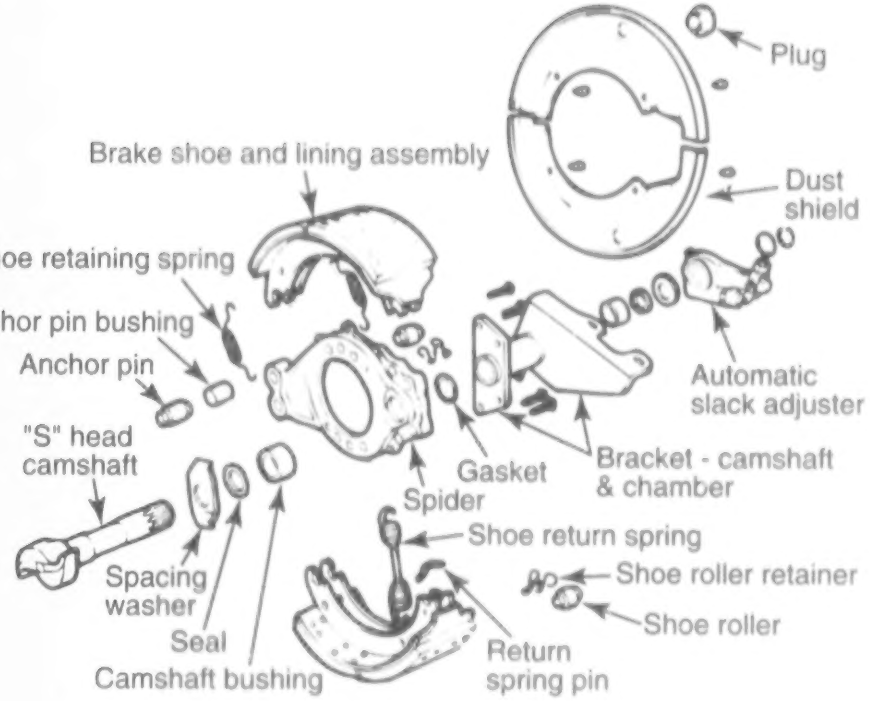
Courtesy of Meritor Automotive, Inc.


Air service chamber
Lining (pads)
Caliper
Slack adjuster
Power shaft
Torque plate
Rotor (disc)

**Disc Brake**

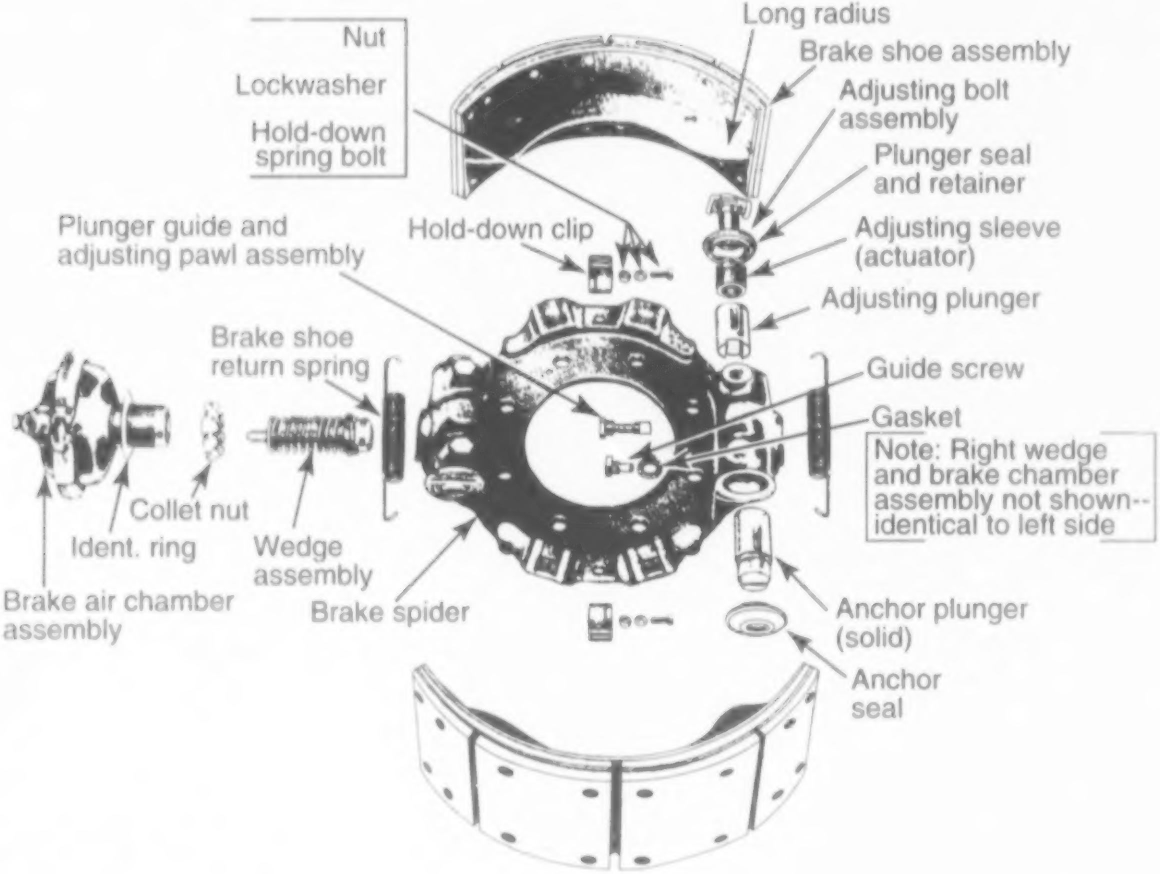
Courtesy of Haldex Midland Services

# Parts of a Cam Foundation Brake


Plug
Brake shoe and lining assembly
Dust shield
Shoe retaining spring
Anchor pin bushing
Anchor pin
Automatic slack adjuster
"S" head camshaft
Gasket
Bracket - camshaft & chamber
Spider
Shoe return spring
Shoe roller retainer
Spacing washer
Shoe roller
Seal
Return spring pin
Camshaft bushing

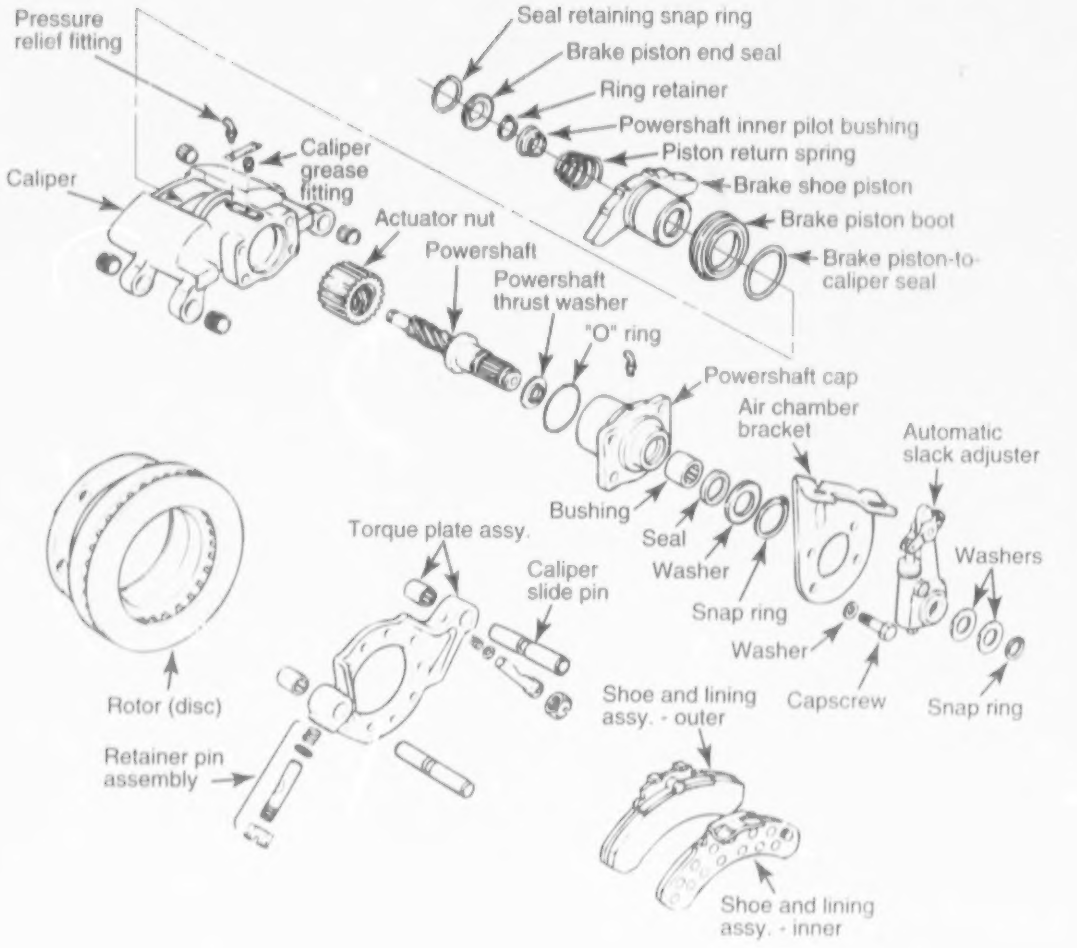
Courtesy of Meritor Automotive, Inc.

# Parts of a Wedge Foundation Brake


Nut
Lockwasher
Hold-down spring bolt
Long radius
Brake shoe assembly
Adjusting bolt assembly
Plunger seal and retainer
Plunger guide and adjusting pawl assembly
Hold-down clip
Adjusting sleeve (actuator)
Adjusting plunger
Brake shoe return spring
Guide screw
Gasket
Note: Right wedge and brake chamber assembly not shown-- identical to left side
Collet nut
Ident. ring
Wedge assembly
Brake air chamber assembly
Brake spider
Anchor plunger (solid)
Anchor seal

Courtesy of Mentor Automotive, Inc.

# Parts of a Disc Foundation Brake

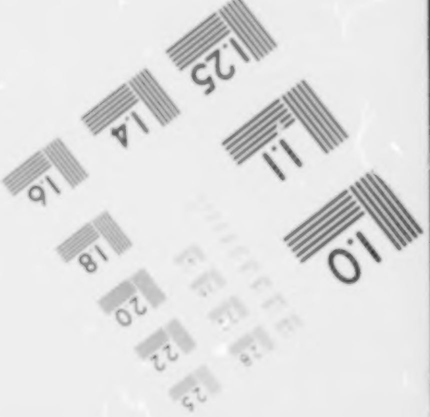

Pressure relief fitting
Seal retaining snap ring
Brake piston end seal
Ring retainer
Powershaft inner pilot bushing
Piston return spring
Caliper
Caliper grease fitting
Brake shoe piston
Brake piston boot
Actuator nut
Powershaft
Brake piston-to-caliper seal
Powershaft thrust washer
"O" ring
Powershaft cap
Air chamber bracket
Automatic slack adjuster
Bushing
Seal
Washer
Snap ring
Torque plate assy.
Caliper slide pin
Washers
Washer
Capscrew
Snap ring
Rotor (disc)
Shoe and lining assy. - outer
Retainer pin assembly
Shoe and lining assy. - inner

Courtesy of Meritor Automotive, Inc.

BEST COPY AVAILABLE

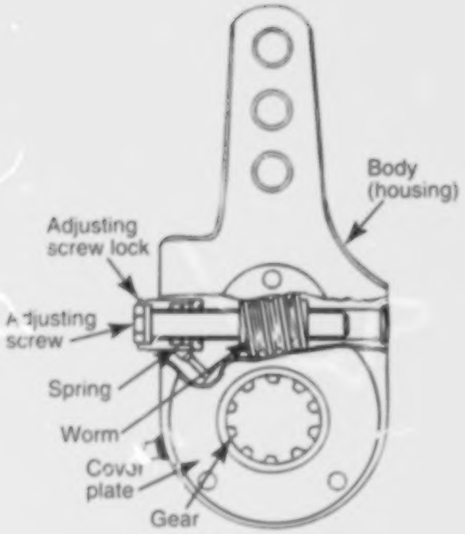
**Association for Information and Image Management**
1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910
301/587-8202

Centimeter
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 mm
1 2 3 4 5
Inches



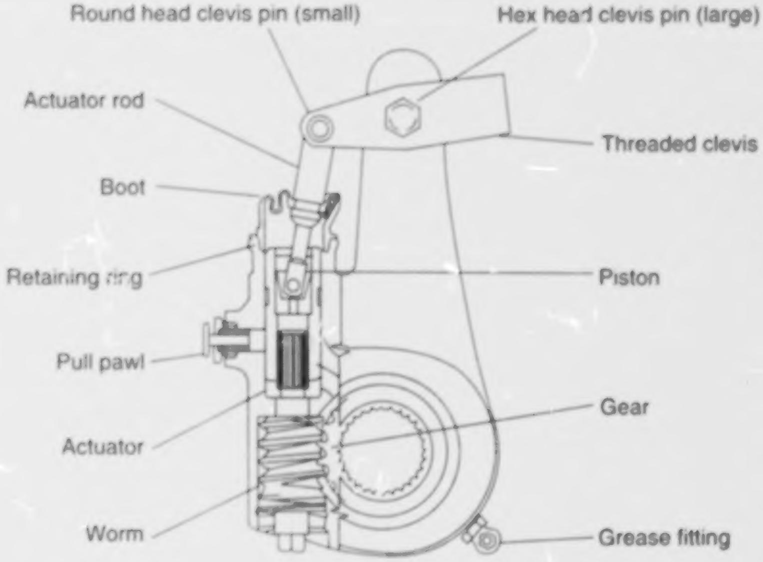
MANUFACTURED TO AIIM STANDARDS
BY APPLIED IMAGE, INC.

# Parts of Slack Adjusters


Body (housing)
Adjusting screw lock
Adjusting screw
Spring
Worm
Cover plate
Gear

**Manual Slack Adjuster**

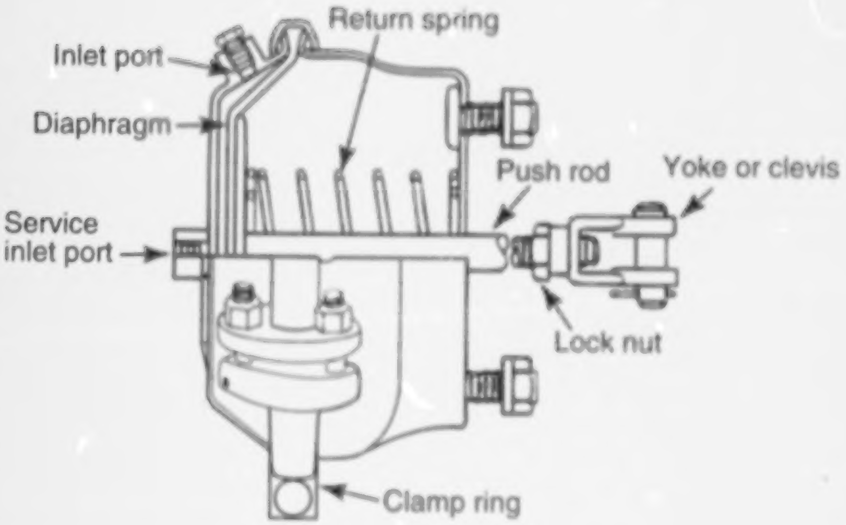
Courtesy of Navistar International Transportation Corp.


Round head clevis pin (small)
Hex head clevis pin (large)
Actuator rod
Threaded clevis
Boot
Retaining ring
Piston
Pull pawl
Gear
Actuator
Worm
Grease fitting

**Automatic Slack Adjuster**

Courtesy of Meritor Automotive, Inc.

# Parts of a Service Brake Chamber (Front Axle)


Return spring
Inlet port
Diaphragm
Push rod
Yoke or clevis
Service inlet port
Lock nut
Clamp ring

Courtesy of Haldex Midland Services

## Air Foundation Brakes
## Unit 1-C

### Written Test

Name _________ ____________________ Date ____________ Score ____________

1. Match the terms on the right with the correct definitions. Definitions continue on the next page.

_______ a. Device that retracts brake shoes upon release of the brake treadle

_______ b. Flexible membrane that moves in response to changes in air pressure

_______ c. Reduction in braking force, usually caused by the inability of the brake lining to maintain its lower temperature effectiveness as the brakes get hot

_______ d. Pin connecting the arm of a slack adjuster to a brake chamber push rod

_______ e. Device that physically initiates the mechanical motion of a brake system component

_______ f. Linear distance traveled by a brake chamber push rod or slack adjuster arm during brake application

_______ g. Return of brake lining to its previous (pre-fade) friction level after a hot run

_______ h. Failure of one or more brakes to release immediately and/or completely after driver removes foot from brake treadle

_______ i. Part of wheel assembly that is engaged by the brake shoes to slow or stop the vehicle

_______ j. Device that provides a means of adjusting clearance between brake shoes and drum to compensate for lining wear

_______ k. Mechanical part with an irregular shape so that the rotation of the part causes movement of another part

_______ l. Hardware used to retain brake shoes within the brake assembly

_______ m. Tandem-chamber brake actuator that incorporates an air-applied service brake chamber and an air-release/spring-applied parking or emergency brake chamber

1. Actuator
2. Anchor pin
3. Brake drag
4. Brake fade
5. Caliper
6. Cam
7. Clearance
8. Clevis pin
9. Coefficient of friction
10. Diaphragm
11. Drum
12. Foundation brake
13. Parking brake
14. Recovery
15. Return spring
16. Service brake
17. Slack adjuster
18. Spring brake
19. Stroke

_______ n. Clamping device used in a disc brake system that applies braking force to both sides of the rotor

_______ o. Number that describes the gripping capacity of a material

_______ p. Part of brake system designed to hold the vehicle in place when vehicle is parked

_______ q. Actual braking mechanism at each end of the axle

_______ r. Portion of the brake system used for normal brake applications

2. Distinguish among the basic components that make up air foundation brakes by placing a "B" next to brake chamber or actuator components, an "S" next to slack adjuster or wedge assembly components, and an "M" next to mechanical brake mechanism components.

_______ a. Applies the force needed to stop the vehicle

_______ b. Joins the air system to the mechanical brake system

_______ c. Transfers movement from brake chamber push rod to apply the brakes

_______ d. Serves as the link between the brake chamber or actuator and the mechanical brake mechanism

_______ e. Converts air pressure into mechanical force

_______ f. Includes the brake linings (friction material), brake drums and shoes, or brake discs (rotors) and pads

3. Match the types of air foundation brakes on the right with their descriptions.

_______ a. Is linked to the air system and service brake chamber by the slack adjuster which is installed on the brake camshaft; is the most common design of air foundation brakes used today

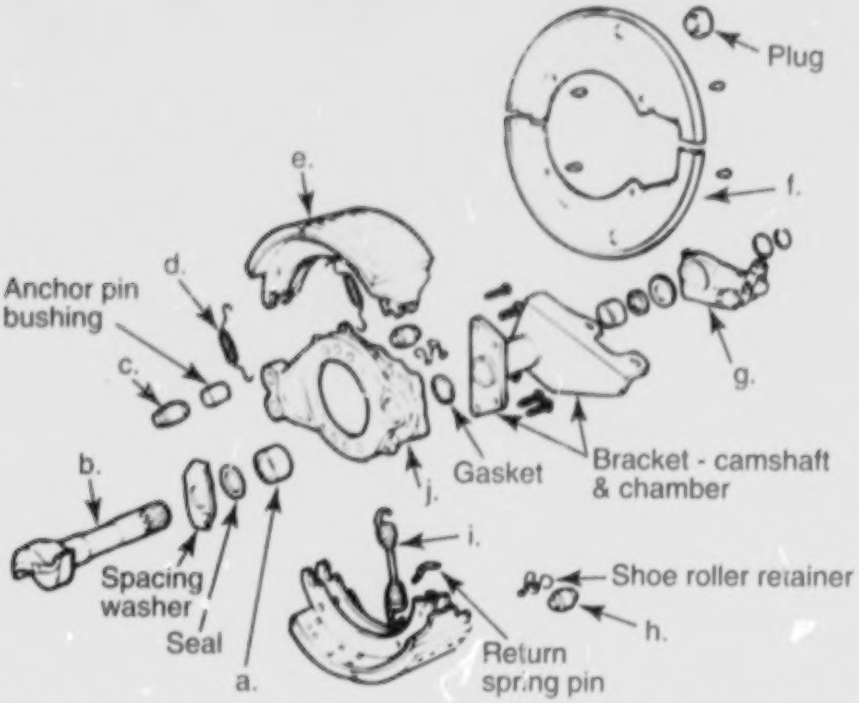
_______ b. Does not use slack adjuster or camshaft; instead uses a mechanism that spreads the brake shoes and forces them against the drum. The mechanism is enclosed within the actuator and chamber tube.

_______ c. Uses a powershaft screw and nut to force the piston and inboard lining against the rotor. This engages the caliper which puts the outboard pad into contact with the rotor. The result is clamping force on both sides.

1. Cam (or s-cam)
2. Disc
3. Wedge

## Written Test

4. Identify the parts of a cam foundation brake. Write your answers in the blanks below.


Plug
e.
f.
d.
Anchor pin bushing
c.
g.
b.
Gasket
Bracket - camshaft & chamber
j.
i.
Spacing washer
Seal
a.
Shoe roller retainer
h.
Return spring pin

Courtesy of Meritor Automotive, Inc

a. ______________________

b. ______________________

c. ______________________

d. ______________________

e. ______________________

f. ______________________

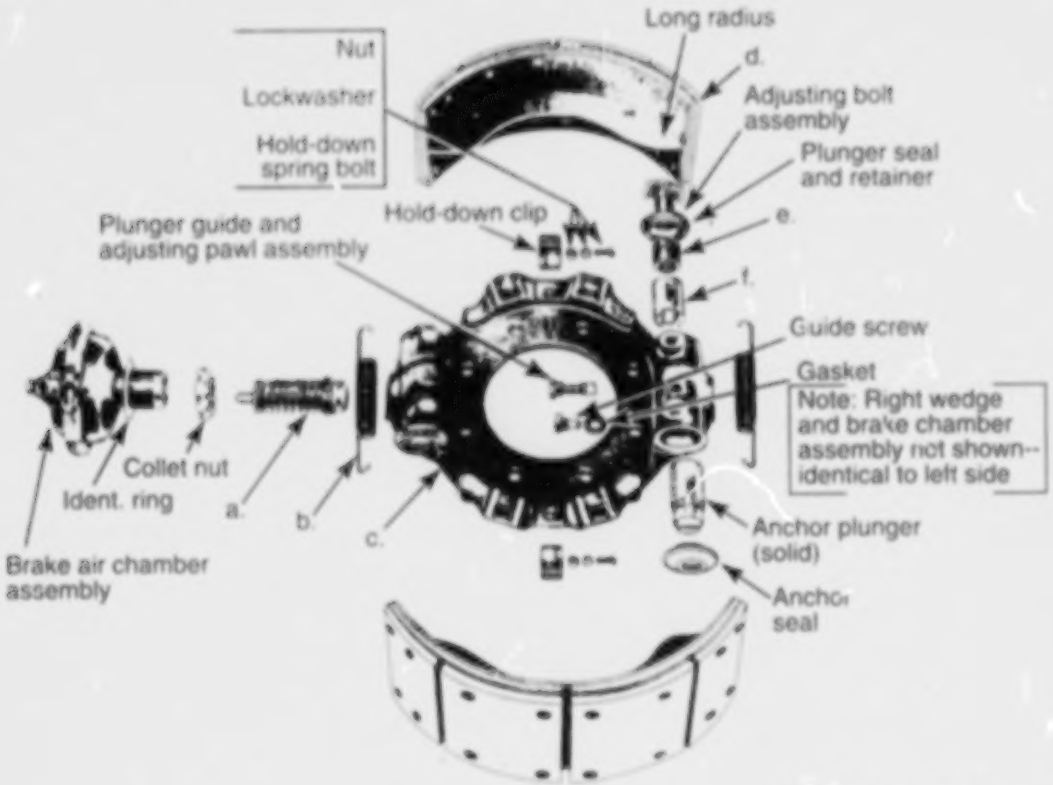
g. ______________________

h. ______________________

i. ______________________

j. ______________________

5. Identify the parts of a wedge foundation brake. Write your answers in the blanks below.


Long radius
d.
Nut
Lockwasher
Hold-down spring bolt
Adjusting bolt assembly
Plunger seal and retainer
Hold-down clip
Plunger guide and adjusting pawl assembly
e.
f.
Guide screw
Gasket
Note: Right wedge and brake chamber assembly not shown--identical to left side
Collet nut
Ident. ring
a.
b.
c.
Anchor plunger (solid)
Brake air chamber assembly
Anchor seal

Courtesy of Meritor Automotive, Inc.

a. ______________________________

b. ______________________________

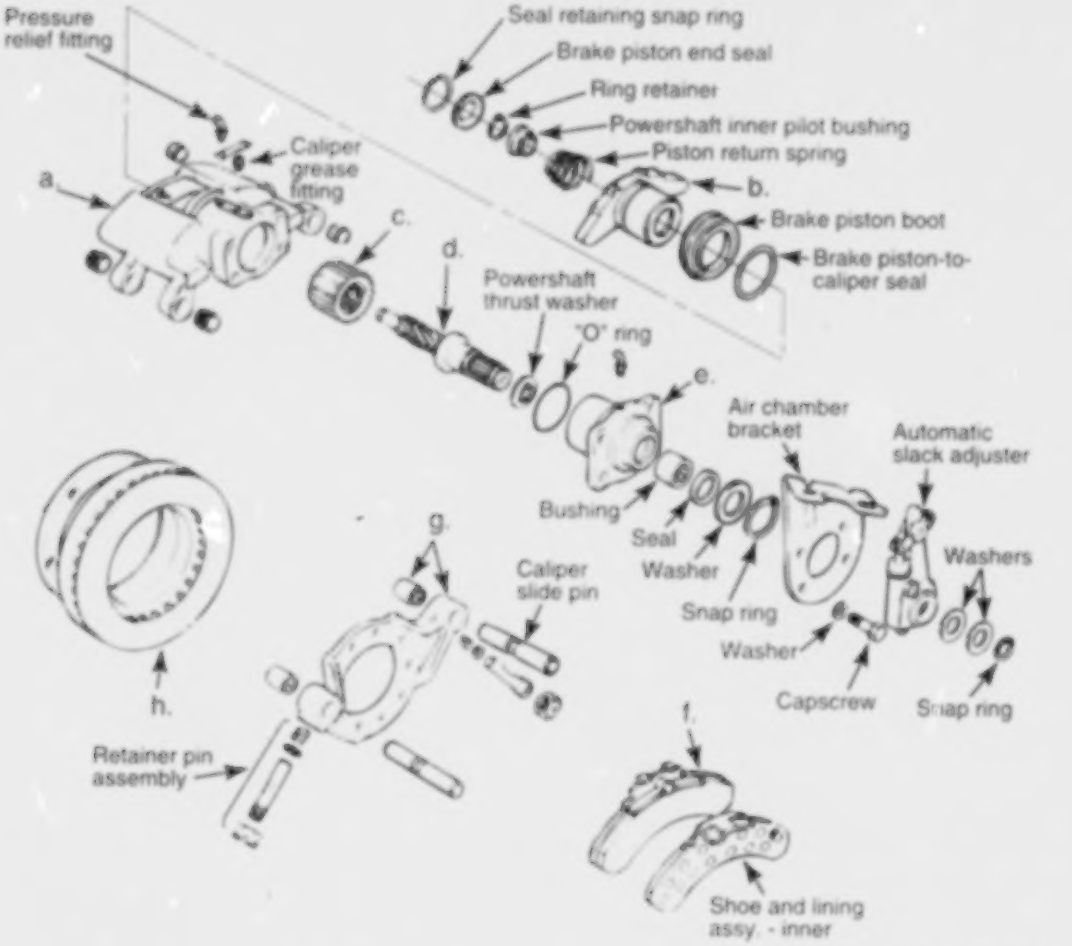
c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

6. Identify the parts of a disc foundation brake. Write your answers in the blanks below.


Pressure relief fitting
Seal retaining snap ring
Brake piston end seal
Ring retainer
Powershaft inner pilot bushing
Piston return spring
Caliper grease fitting
a.
b.
Brake piston boot
c.
Brake piston-to-caliper seal
d.
Powershaft thrust washer
"O" ring
e.
Air chamber bracket
Automatic slack adjuster
Bushing
Seal
Washer
Snap ring
Washers
g.
Caliper slide pin
Washer
Capscrew
Snap ring
h.
f.
Retainer pin assembly
Shoe and lining assy. - inner

Courtesy of Meritor Automotive, Inc.

a. ______________________ b. ______________________

c. ______________________ d. ______________________

e. ______________________ f. ______________________

g. ______________________ h. ______________________

## Written Test

7. Distinguish between the types of shoe assembly anchors by placing an "F" next to descriptions of fixed anchor pins and an "R" next to descriptions of removable anchor pins.

_______ a. Have open anchor pin openings and a retaining spring to allow for quick relines

_______ b. May be difficult to service because pins often become seized in the pin openings and will have to be forced out

_______ c. Have closed anchor pin openings and anchor pins that must be removed before brake shoe linings can be changed

_______ d. Normally easier to service because pins do not have to be removed for brake shoe lining changes

8. Complete the following statements concerning brake linings, blocks, and pads by circling the correct answers.

   a. Brake lining materials are made of special **(friction, antifriction)** material that is able to withstand the heat created from the braking effort.

   b. Until recently, **(carbon, asbestos)** was the primary material used on brake linings.

   c. Materials are identified by a stencil on its **(front surface, edge)** that gives the name of the manufacturer, material identification, and friction class.

   d. The friction class is indicated by two letters. The first letter represents the **(normal, hot)** coefficient of friction, and the second represents the **(normal, hot)** coefficient of friction.

   e. It takes **(one, two, three)** brake blocks to line one shoe.

   f. Brake block is generally $^{3}/_{4}$" thick and is commonly used on **(smaller, heavy-duty)** vehicles.

   g. Brake lining is generally $^{1}/_{2}$" thick and is commonly used on **(smaller, heavy-duty)** vehicles.

   h. Brake blocks are typically **(wider, narrower)** than linings.

   i. Brake blocks and linings are usually **(bonded, riveted)** onto the shoe.

   j. Brake pads are used on **(disc, drum)** foundation brakes.

## Written Test

9. Complete the following statements concerning guidelines for relining brakes by filling in the blanks with the correct answers.

   a. Make sure that brake shoes are in good condition. Table should be ______________.

   b. Prior to disassembly, check the lining wear on all brakes. If wear is ______________, the brake balance is correct.

   c. Use the friction material specified by the ______________________________ for all relines.

   d. Replace the full hardware kit and change the ______________________________, especially if a difference in wear is noted between the two shoes.

   e. Make sure that the shoe is not ________________________.

   f. Check for ______________________ between the lining and the shoe table.

10. Distinguish between the types of brake drum assembly arrangements by placing an "I" next to inboard arrangement(s) and an "O" next to outboard arrangement(s).

    ______ a. Wheel and drum assembly must be removed as a unit in order for drum to be removed from hub

    ______ b. Drum may be removed without having to remove hub assembly; is quicker for brake service

11. Describe the types of slack adjusters.

    a. Manual— ________________________________________

    ________________________________________

    b. Automatic— ________________________________________

    ________________________________________

12. List three advantages of automatic slack adjusters.

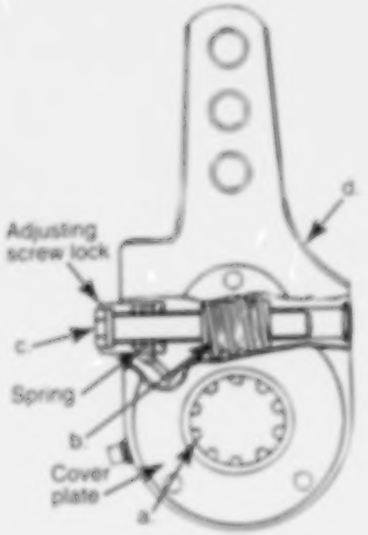
    a. ________________________________________

    b. ________________________________________

    c. ________________________________________

13. Identify the parts of slack adjusters. Write your answers in the blanks provided.

- Manual slack adjuster


d.
Adjusting screw lock
c.
Spring
b.
Cover plate
a.

Courtesy of Navistar International Transportation Corp.

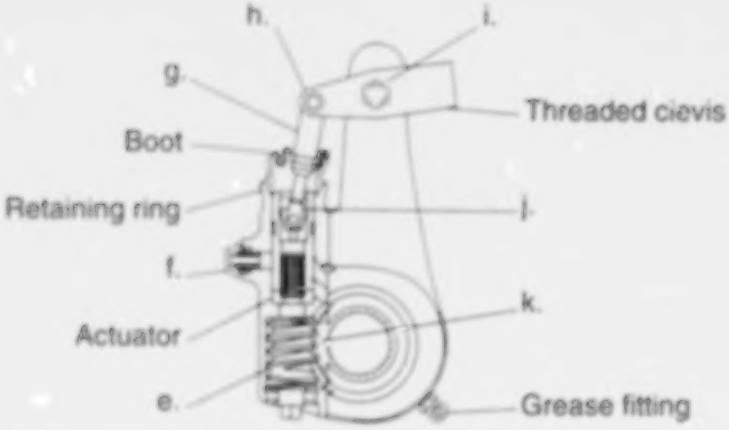
a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

- Automatic slack adjuster



Courtesy of Meritor Automotive, Inc.

e. ______________________________

f. ______________________________

g. ______________________________

h. ______________________________

i. ______________________________

j. ______________________________

k. ______________________________

14. Distinguish between correct and incorrect guidelines for working on slack adjusters by placing an "X" next to the correct guidelines.

_______ a. Slack adjusters convert the linear force of the brake chamber push rod into a twisting force that turns the brake camshaft.

_______ b. The clevis pins are used for brake clearance adjustment.

_______ c. Slack adjusters are available in only one configuration.

_______ d. Replace slack adjusters with the same size and type as the original equipment.

_______ e. Slack adjuster numbers represent minimum size rating.

_______ f. It is acceptable to mix automatic slack adjusters with manual slack adjusters on the same vehicle.

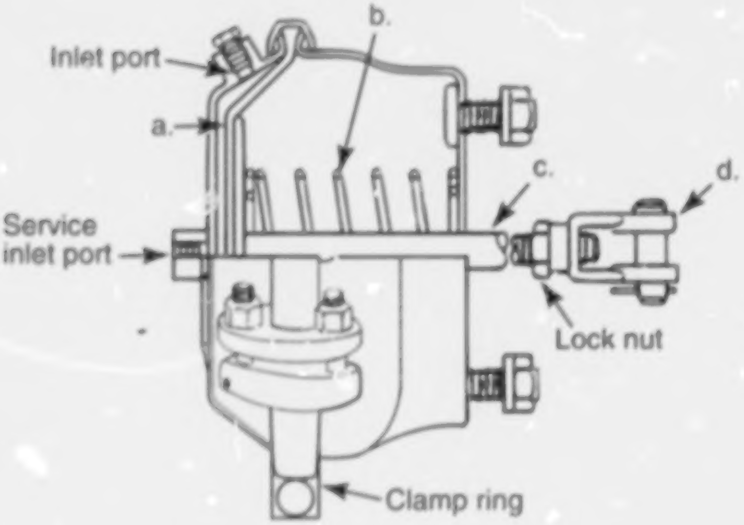
_______ g. It is also acceptable to mix automatic slack adjusters from different manufacturers on the same vehicle and axle.

_______ h. Follow the manufacturer's instructions for adjustment of slack adjusters. Make sure you have the proper templates and measuring tools required for the job.

_______ i. Follow all safety precautions, especially as they relate to the service brake chamber and the spring brake chamber which are connected to the slack adjuster.

_______ j. Never block the wheel or release the brakes prior to removing or installing a slack adjuster.

15. Identify the parts of a service brake chamber (front axle). Write your answers in the blanks below.



Courtesy of Haldex Midland Services

a. ________________________________________

b. ________________________________________

c. ________________________________________

d. ________________________________________

## Written Test

16. Arrange in order the steps in the operation of a typical service brake chamber by placing the numbers 1–4 in the appropriate blanks.

    ______ a. Push rod acts upon either the slack adjuster (cam brakes) or the wedge assembly (wedge brakes).

    ______ b. Air pressure acts upon the diaphragm, moving the push rod forward.

    ______ c. Controlled air pressure enters the brake chamber through the inlet port.

    ______ d. When air pressure is released from the brake chamber, the push rod return spring in combination with the brake shoe return springs return the diaphragm and push rod assembly to their released position.

17. Select true statements concerning guidelines for working on service brake chambers by placing an "X" next to the true statements.

    ______ a. Always maintain the brake chambers to their original performance condition.

    ______ b. If the chamber return springs need replacement, the springs should be replaced with springs of greater spring load.

    ______ c. Always replace the return spring on both chambers on an axle.

    ______ d. Replace all diaphragms on the vehicle at the same time.

    ______ e. Prior to installing a new brake chamber, the new push rod should be compared to the length of the old push rod with the excess rod cut off with a hacksaw.

    ______ f. Make sure the chamber push rods are in line with the slack adjusters.

    ______ g. Ideally, the chamber push rod length should be adjusted so that when the chamber reaches half its maximum stroke, a 60° angle is formed between the slack adjuster and the chamber push rod.

18. Discuss the main check points for inspecting the following foundation components.

    a. Springs (return and retaining)— ____________________________________________

    ____________________________________________________________

    ____________________________________________________________

    b. Cam shafts, bushings, and brackets— ____________________________________________

    ____________________________________________________________

    ____________________________________________________________

    c. Spider— ____________________________________________

    ____________________________________________________________

    ____________________________________________________________

## Written Test

d. Brake drum— ______________________________

______________________________

______________________________

e. Brake chamber— ______________________________

______________________________

______________________________

f. Slack adjuster— ______________________________

______________________________

______________________________

Permission to duplicate this test is granted.

# Air Foundation Brakes
# Unit 1-C

## Answers to Written Test

1. 
   - a. 15
   - b. 10
   - c. 4
   - d. 8
   - e. 1
   - f. 19
   - g. 14
   - h. 3
   - i. 11
   - j. 17
   - k. 6
   - l. 2
   - m. 18
   - n. 5
   - o. 9
   - p. 13
   - q. 12
   - r. 16

2. 
   - a. M
   - b. B
   - c. S
   - d. S
   - e. B
   - f. M

3. 
   - a. 1
   - b. 3
   - c. 2

4. 
   - a Camshaft bushing
   - b. "S" head camshaft
   - c. Anchor pin
   - d. Shoe retaining spring
   - e. Brake shoe and lining assembly
   - f. Dust shield
   - g. Automatic slack adjuster
   - h. Shoe roller
   - i. Shoe return spring
   - j. Spider

5. 
   - a. Wedge assembly
   - b. Brake shoe return spring
   - c. Brake spider
   - d. Brake shoe assembly
   - e. Adjusting sleeve (actuator)
   - f. Adjusting plunger

6. 
   - a. Caliper
   - b. Brake shoe piston
   - c. Actuator nut
   - d. Powershaft
   - e. Powershaft cap
   - f. Shoe and lining assembly—outer
   - g. Torque plate assembly
   - h. Rotor (disc)

7. 
   - a. F
   - b. R
   - c. R
   - d. F

## Answers to Written Test

8. a. Friction
   b. Asbestos
   c. Edge
   d. Normal, hot
   e. Two
   f. Heavy-duty
   g. Smaller
   h. Wider
   i. Riveted
   j. Disc

9. a. Flat (distortion-free)
   b. Even (same)
   c. Original equipment manufacturer (OEM)
   d. Cam bushings
   e. Stretched (distorted)
   f. Gaps

10. a. I
    b. O

11. a. **Manual**—Must be periodically checked and readjusted to compensate for brake lining wear
    b. **Automatic**—Automatically adjusts the clearance between the brake linings and the brake drum or rotor during normal service braking applications

12. Any three of the following:
    a. Automatic brake adjustment
    b. Reduced downtime and maintenance costs
    c. Improved brake balance
    d. Reduced chamber travel and less air consumption
    e. Consistent, reliable spring brake engagement

13. • Manual slack adjuster
    a. Gear
    b. Worm
    c. Adjusting screw
    d. Body (housing)
    • Automatic slack adjuster
    e. Worm
    f. Pull pawl
    g. Actuator rod
    h. Round head clevis pin (small)
    i. Hex head clevis pin (large)
    j. Piston
    k. Gear

14. a, d, h, i

15. a. Diaphragm
    b. Return spring
    c. Push rod
    d. Yoke or clevis

203

## Answers to Written Test

16.
   a. 3
   b. 2
   c. 1
   d. 4

17. a, c, d, e, f

18. Any one answer for each of the following:
   a. **Springs—Return and retaining**
      1) Check to see that the shoes fully retract upon brake release.
      2) Replace at each reline.
   b. **Cam shafts, bushings, and brackets**
      1) Inspect the cam and its shaft for irregular surfaces, flat spotting, cracks, wear, and corrosion. Make sure the cam surface, bearing journals, and splines are smooth and free of ridges.
      2) Wiggle the cam up and down to check for radial play, and in and out to check for end play. Check with a dial indicator if any play is felt.
      3) Replace cam bushings and seals at each reline.
      4) Inspect the cam shaft bracket for broken welds, cracks, loose mounting fasteners, bending, and misalignment.
   c. **Spider**
      1) Check for elongated anchor pin holes, cracks, and proper alignment.
      2) Also check the single anchor pin spider for anchor pin wear and looseness in the spider.
   d. **Brake drum**—Check for scoring, cracking, excessive inner diameter, and/or runout.
   e. **Brake chamber**—Check for cracks, clogged vent holes, bent push rods, and for loose mountings, air fittings, and clamp rings.
   f. **Slack adjuster**—Check for cracks, damaged splines, worn clevis pin bushings, and sticky adjustment nuts.

# Air Foundation Brakes
# Unit 1-C

## Unit Evaluation Form

Student Name ______________________________ Unit Rating ____________

Job Sheet 1—Inspect, Service, and Adjust Slack Adjuster on Front Axle Rating ______

Comments: ____________________________________________________

____________________________________________________________

Job Sheet 2—Inspect, Test, Service, and Replace Service Brake Chamber Rating ______

Comments: ____________________________________________________

____________________________________________________________

Job Sheet 3—Remove, Inspect, and Replace Brake Shoes, Drum, and Hardware for S-Cam Drum Foundation Brakes Rating ______

Comments: ____________________________________________________

____________________________________________________________

Job Sheet 4—Remove, Inspect, and Replace Brake Shoes, Drum, and Hardware for Wedge-Type Drum Foundation Brakes Rating ______

Comments: ____________________________________________________

____________________________________________________________

Job Sheet 5—Inspect, Clean, and Measure Brake Calipers, Pads, and Rotors; Replace Pads if Needed Rating ______

Comments: ____________________________________________________

____________________________________________________________

**Written Test Scores**

Pretest ________ Posttest ________ Other ________

Other ________________________________________________________

____________________________________________________________

**Teacher Signature** __________________________ Date ____________

**Student Signature** __________________________ Date ____________

Permission to duplicate this form is granted.

# Air Supply System
# Unit 2-C

## Unit Contents

**Teacher Components** **Teacher Page**

1. Suggested Activities

a. Instructional Plan .....1
b. Teaching Suggestions .....2
c. Resources Used in Developing This Unit .....3
d. Suggested Supplemental Resource .....3
e. Instructions for Evaluating Student Performance .....4

2. Transparency Masters

1—Components of the Air Supply System .....5
2—Parts of a Compressor .....7
3—Parts of a Compressor (Continued) .....9
4—Compressor Loading and Unloading Process .....11
5—Parts and Ports of an Air Dryer .....13
6—Parts and Ports of an Air Dryer (Continued) .....15
7—Air Dryer Drying Cycle .....17
8—Air Dryer Purge Cycle .....19

3. Answers to Assignment Sheet 1 .....21

4. Written Test .....23

5. Answers to Written Test .....33

6. Unit Evaluation Form .....35

**Student Components** **Student Page**

DT:B

1. Objective Sheet .....C-47

2. Information Sheet .....C-49

3. Assignment Sheet

1—Identify and Connect Components in an Air Supply System .....C-63

4. Job Sheets

1—Service the Reservoir and Check Valve Function, Build-Up Time, and Cut-Out Pressure .....C-65
2—Inspect and Service Belt-Driven Compressor and Associated Lines .....C-69
3—Inspect, Service, and Time Gear-Driven Compressor, Valves, and Associated Lines .....C-73
4—Inspect and Service Air Dryer System; Repair or Replace as Needed .....C-79

# Air Supply System
# Unit 2-C

## Suggested Activities

### Instructional Plan

### Preparation

1. Read the unit carefully and plan for instruction.
2. Review "Teaching Suggestions." Plan for classroom activities.
3. Plan for students with special needs.
4. Obtain videotapes, service manuals, and other resources to supplement instruction of this unit. See "Resources" for more information.
5. Make transparencies from the transparency masters included in this unit.
6. Develop teaching plan. Adjust for different learning styles.
7. Review "Instructions for Evaluating Student Performance."
8. Make copies of the Unit Evaluation Form, one for each student.

### Delivery and Application

9. Provide students with unit of instruction.
10. Discuss unit and specific objectives.
11. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
12. Discuss the assignment sheet. Review criteria for evaluation of these activities.
13. Discuss and demonstrate the job sheets. Make sure all required tools, equipment, and supplies are available. Review criteria for evaluation of these activities.

### Evaluation

14. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.
15. Make copies of the written test. Add or modify test items as needed.
16. Give written test.
17. Compile assignment sheet ratings, job sheet ratings, and written test scores on the Unit Evaluation Form. Add any additional assignments or supplemental activities that should be part of the unit evaluation.
18. Reteach and retest as required.

## Suggested Activities

### Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A Report for America 2000* and *Workplace Basics: The Skills Employers Want.* These have been adapted by MAVCC.

1. Introduce the unit by demonstrating how compressed air can be stored in a reservoir. Have the students think about how impractical it would be to have the air compressor run all the time just to power the brakes directly when they are needed. **(Thinking Skills—Problem solving)**

2. Discuss other truck systems that may receive power from the air supply system, such as windshield wipers, power steering, air-assisted shifters, etc. State that although this unit deals with air brakes, the service technician must be aware of the use of compressed air for other systems and the service requirements to support those systems. **(Information—Acquisition; Systems—Interrelationships)**

3. Discuss build-up time and its impact on air brake functioning. Use this discussion to introduce federal and state regulation of truck design and operation, with particular emphasis on FMVSS 121. Point out that the regulations were so profound that people in the industry frequently speak of "pre-121" vehicles or "121 trucks." Discuss other timing requirements such as application and release timing requirements. **(Thinking Skills—Problem solving; Information—Acquisition)**

4. Relate the various components of the air supply system to its purpose, and explain the operation of each component and auxiliary components such as lines, relief valves, check valves, etc. **(Information—Acquisition; Systems—Interrelationships)**

5. Display examples of hoses, tubing, and desiccants.

6. Show students various types of compressors. Demonstrate compressor operation and relate it to output, cut-off setting, and unloading. **(Information—Acquisition; Systems—Interrelationships)**

7. Demonstrate compressor operation and brake operation with a clogged filter. Discuss problems that can develop as a result of clogged or defective filters, including wear and overheating of the compressor and inadequate braking. **(Thinking Skills—Problem solving; Technology—Maintenance and troubleshooting)**

8. Discuss the advantages and disadvantages of rebuilding an air compressor versus installing a new or rebuilt unit. Review economic considerations, as well as the task associated with overhaul. **(Thinking Skills—Decision making; Resources—Time and money; Technology—Maintenance and troubleshooting)**

9. Discuss regulatory and manufacturer recommendations as they impact air compressor selection. For example, point out that most manufacturers require that the air from a compressor be less than 400°F. Therefore, the compressor design must support such requirements. **(Thinking Skills—Reasoning; Technology—Selection)**

10. Show examples of each type of air dryer and various types of desiccant cartridges. Allow the students to feel the desiccant pellets and discuss other uses of desiccants that the students may have encountered, such as in vitamins or electronic packaging. **(Thinking Skills—Reasoning)**

11. Demonstrate air dryer purging and also relate it to contaminants, including particulates. You may want to show the students the debris that collects in filter containers, including the engine air cleaner, and have them speculate about what these contaminants can do to O-rings, valves, brake lines, compression chambers, and other components. **(Thinking Skills—Problem solving and reasoning)**

## Suggested Activities

12. Discuss the effects of water and oil contamination on brake operation and how such contamination is more likely to occur when the tank is not drained. **(Thinking Skills—Reasoning)**

13. Obtain from manufacturers up-to-date service manuals, bulletins, troubleshooting guides, videos, and brochures that explain air supply systems. Provide these to students so that they may study the resources available to them when working on specific components. **(Basic Skills—Reading; Thinking Skills—Knowing how to learn; Technology—Application and troubleshooting)**

14. Display manufacturer's guidelines regarding draining and other maintenance of reservoirs. Demonstrate draining an air tank. Point out automatic drain systems on vehicles in your facility. **(Thinking Skills--Knowing how to learn; Technology—Application and troubleshooting)**

15. Discuss safety precautions to follow when working on air supply systems. Point out previous problems that could have been prevented if students had observed the rules. **(Personal Management Skills—Responsibility and organizational effectiveness [value of safety])**

### Resources Used in Developing This Unit

1. *The Air Brake Book*, 5th revised ed. Radnor, PA: Commercial Carrier Journal.
2. *Air Brake Handbook*. Elyria, OH: AlliedSignal Automotive, Truck Brake Systems Company, 1995.
3. *Air Brake System*. Allentown, PA: Mack Trucks, 1986.
4. *Air Dryers*, Maintenance Manual No. 4CC. Troy, MI: Rockwell International, 1993.
5. *Grey-Rock Heavy Duty Brake Service Manual*. Owosso, MI: Grey-Rock, 1983.
6. Norman, Ian Andrew et al. *Heavy Duty Truck Systems*, 2nd ed. Albany, NY: Delmar Publishers, Inc., 1996.
7. *Workbook and Learning Aid for Air Brake Systems*. Kansas City, MO: Midland-Grau Heavy Duty Systems, 1991.

### Suggested Supplemental Resource

1. Truck Air Brake Service: Servicing the Air Supply System filmstrips. (GA-09430-F).

   Available from:

   National Innovative Media Company (NIMCO)
   Calhoun, KY 42327
   1-800-962-6662

## Suggested Activities

### Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

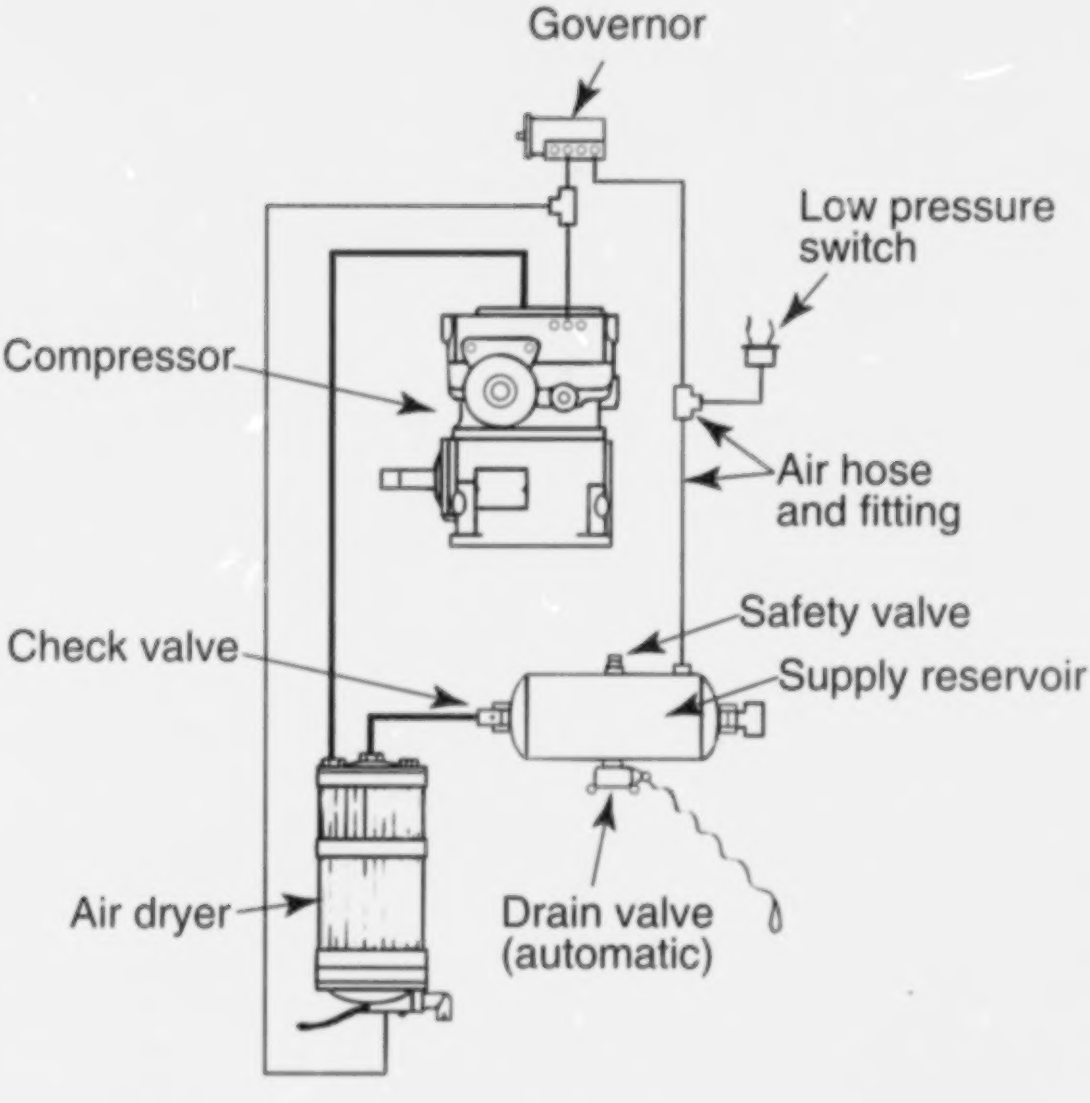
4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

Option B

Yes—Can perform job with no additional training.

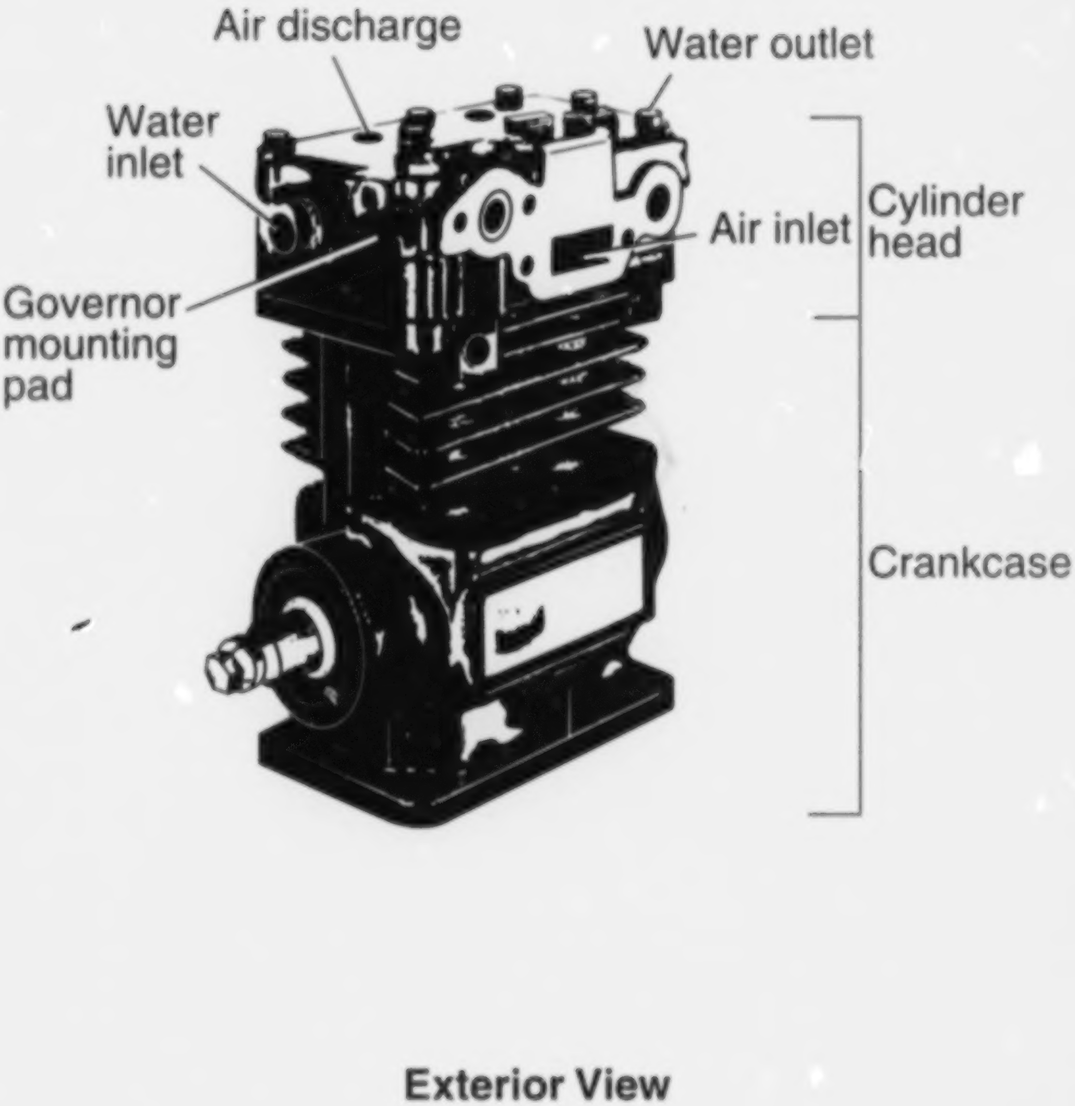
No—Is unable to perform job satisfactorily.

# Components of the Air Supply System


Governor
Low pressure switch
Compressor
Air hose and fitting
Safety valve
Check valve
Supply reservoir
Air dryer
Drain valve (automatic)

Courtesy of Haldex Midland Services

# Parts of a Compressor


Air discharge
Water outlet
Water inlet
Cylinder head
Air inlet
Governor mounting pad
Crankcase

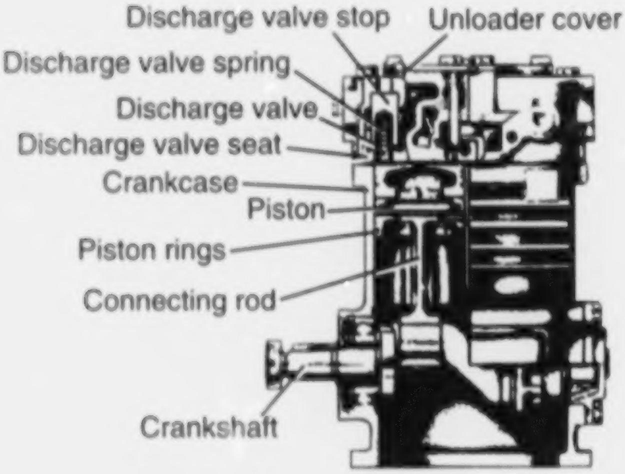
**Exterior View**

Courtesy of AlliedSignal Bendix

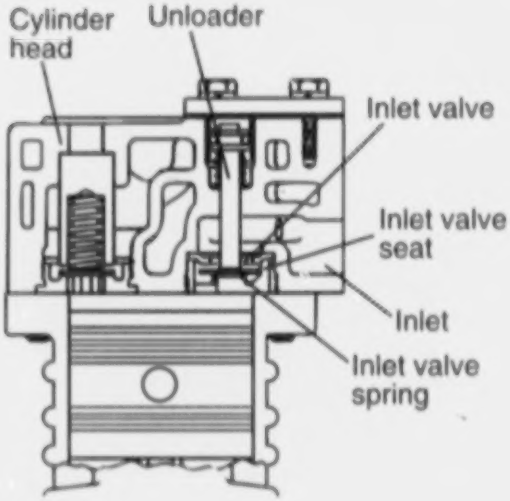
TM 2

# Parts of a Compressor

(Continued)


Discharge valve stop
Unloader cover
Discharge valve spring
Discharge valve
Discharge valve seat
Crankcase
Piston
Piston rings
Connecting rod
Crankshaft

**Cross Section View**

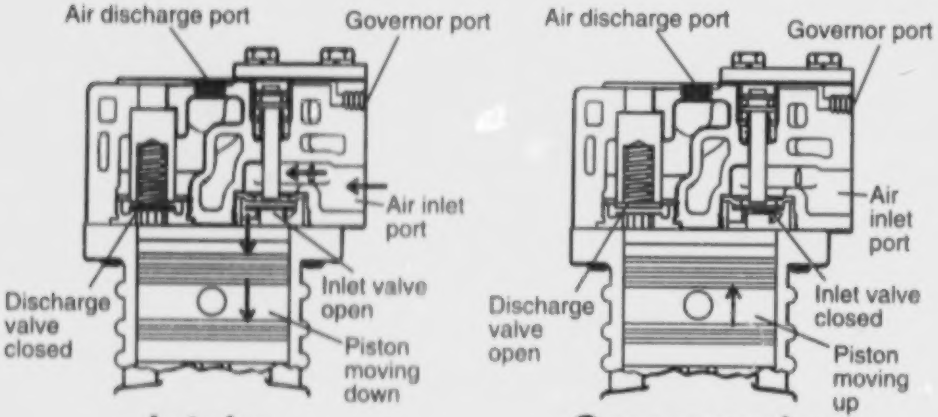

Cylinder head
Unloader
Inlet valve
Inlet valve seat
Inlet
Inlet valve spring

**End View of Cylinder Head**

Courtesy of AlliedSignal Bendix

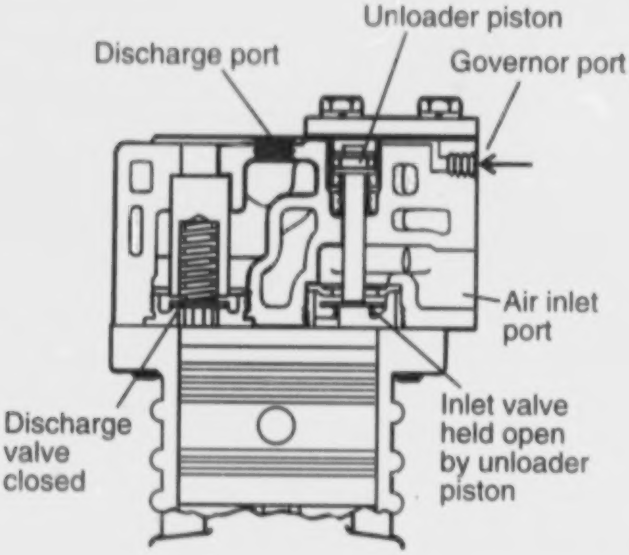
TM 3

# Compressor Loading and Unloading Process


Air discharge port
Governor port
Air inlet port
Discharge valve closed
Inlet valve open
Piston moving down
Air discharge port
Governor port
Air inlet port
Discharge valve open
Inlet valve closed
Piston moving up

**Intake** **Compression**

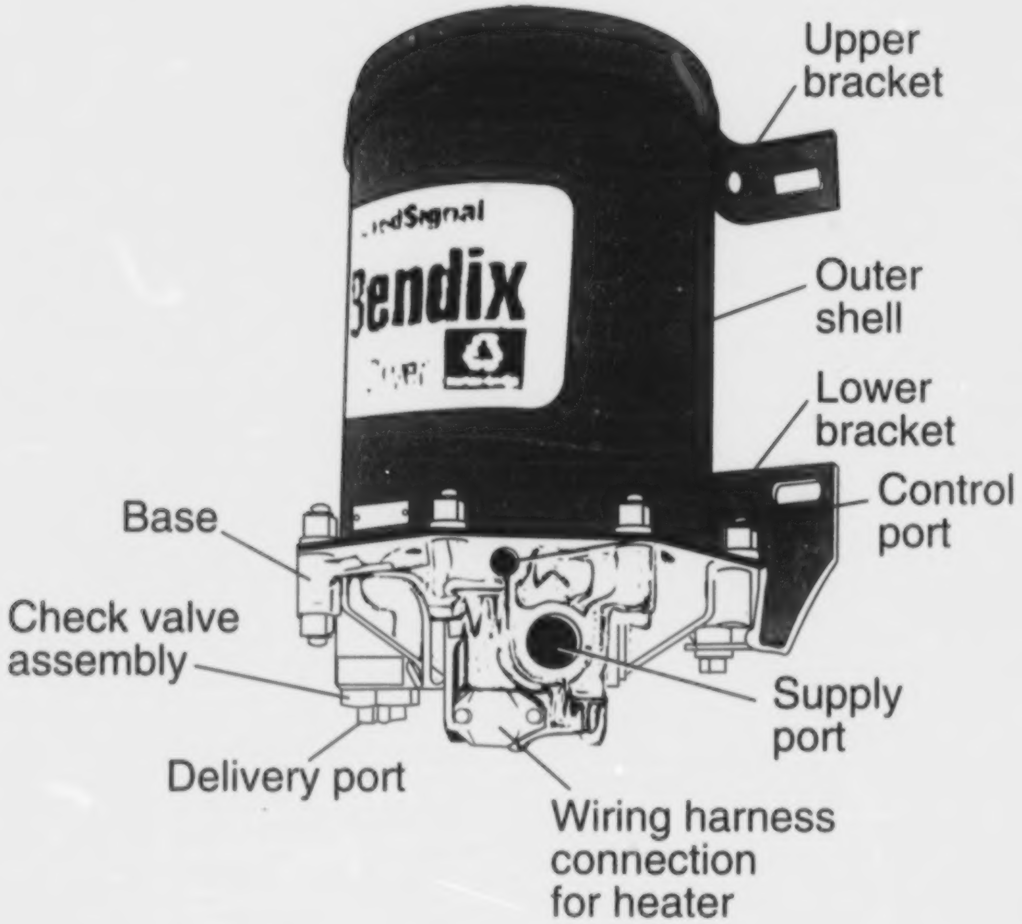
**Loaded**


Unloader piston
Discharge port
Governor port
Air inlet port
Discharge valve closed
Inlet valve held open by unloader piston

**Unloaded**

Courtesy of AlliedSignal Bendix

# Parts and Ports of an Air Dryer



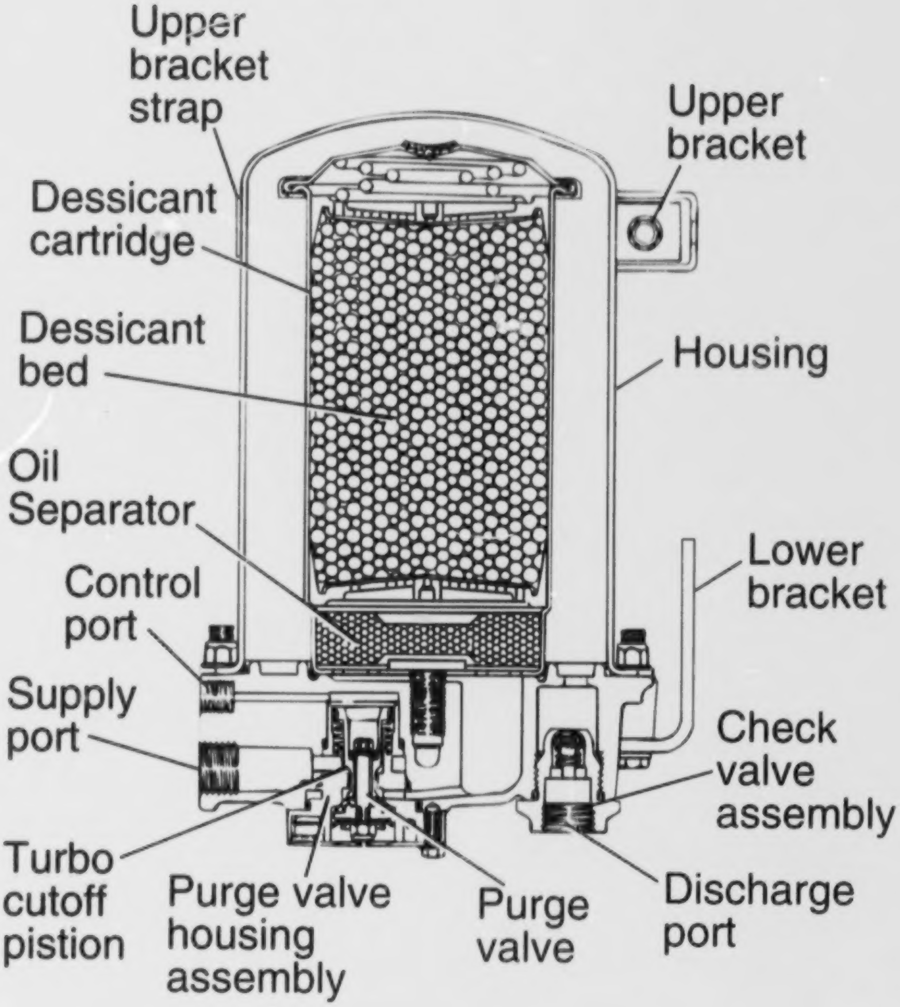
Upper bracket
AlliedSignal
Bendix
Outer shell
Lower bracket
Control port
Base
Check valve assembly
Supply port
Delivery port
Wiring harness connection for heater

## Exterior View

Courtesy of AlliedSignal Bendix

# Parts and Ports of an Air Dryer

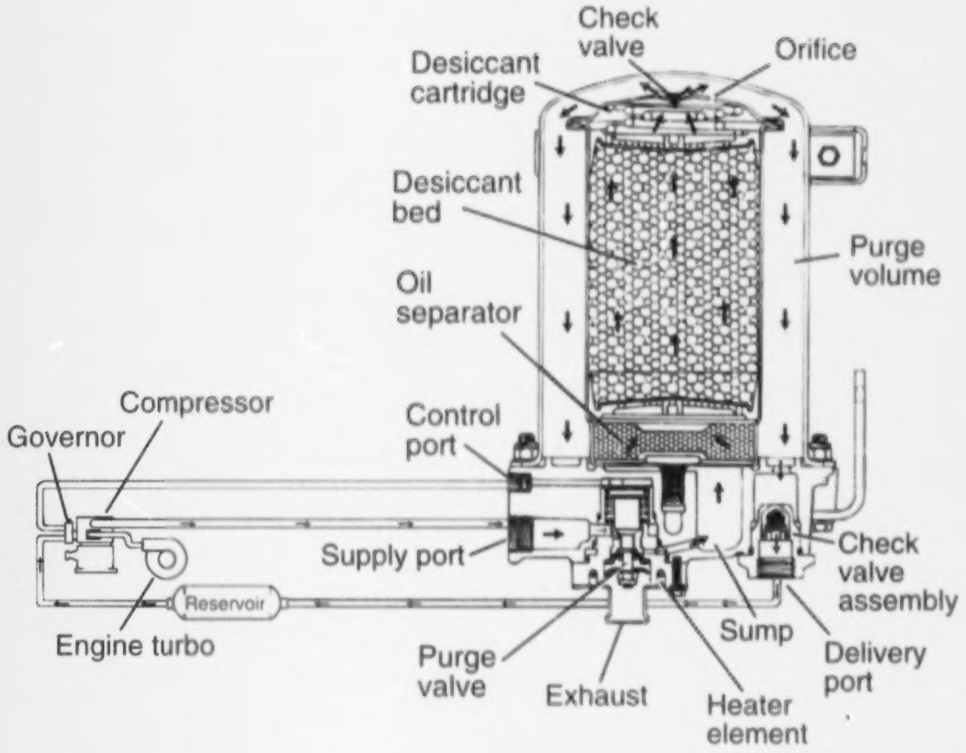
(Continued)


Upper bracket strap
Upper bracket
Dessicant cartridge
Dessicant bed
Housing
Oil Separator
Lower bracket
Control port
Supply port
Check valve assembly
Turbo cutoff pistion
Purge valve housing assembly
Purge valve
Discharge port

## Cross Section View

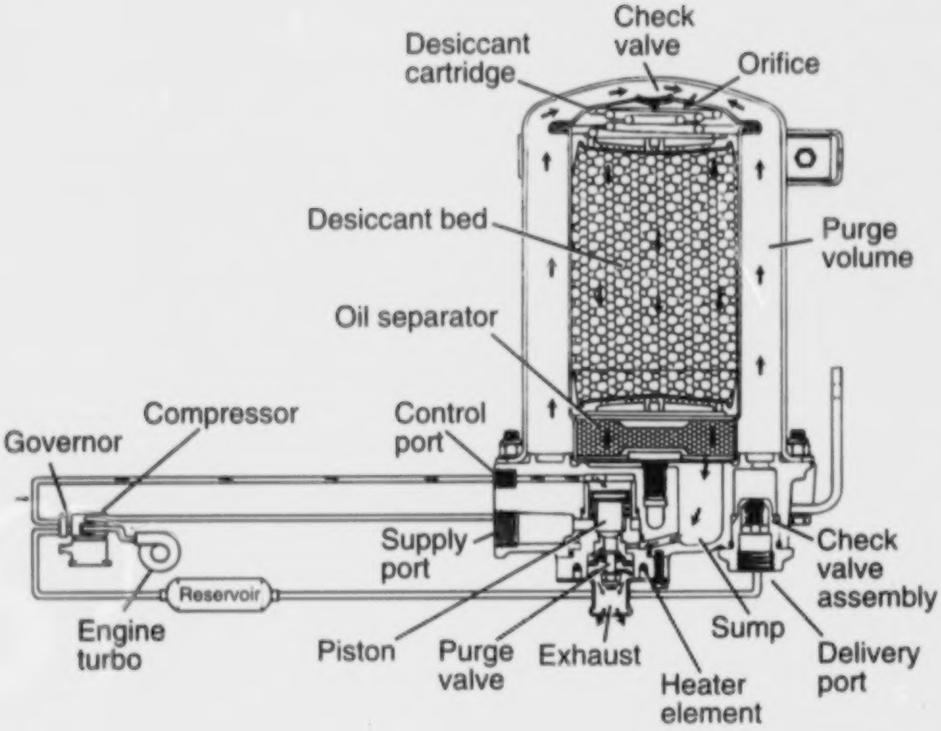
Courtesy of AlliedSignal Bendix

# Air Dryer Drying Cycle


Check valve
Orifice
Desiccant cartridge
Desiccant bed
Purge volume
Oil separator
Compressor
Governor
Control port
Supply port
Reservoir
Engine turbo
Check valve assembly
Sump
Delivery port
Purge valve
Exhaust
Heater element

Courtesy of AlliedSignal Bendix

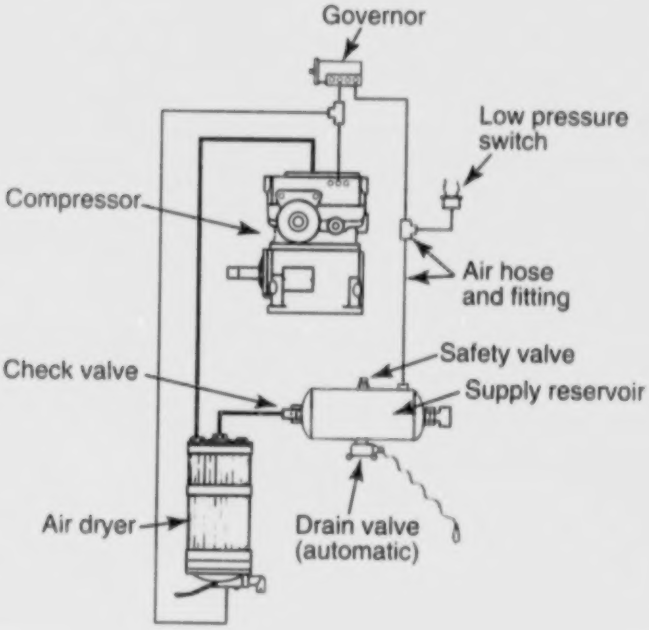
# Air Dryer Purge Cycle


Check valve
Desiccant cartridge
Orifice
Desiccant bed
Purge volume
Oil separator
Compressor
Governor
Control port
Supply port
Check valve assembly
Reservoir
Engine turbo
Piston
Purge valve
Exhaust
Sump
Heater element
Delivery port

Courtesy of AlliedSignal Bendix

# Air Supply System
# Unit 2-C

## Answers to Assignment Sheet 1


Governor
Low pressure switch
Compressor
Air hose and fitting
Safety valve
Check valve
Supply reservoir
Air dryer
Drain valve (automatic)

Courtesy of Haldex Midland Services

# Air Supply System
# Unit 2-C

## Written Test

Name ______________________ Date __________ Score __________

1. Match the terms on the right with the correct definitions.

_______ a. Pressure level in the air system supply reservoir that triggers the compressor unload cycle

_______ b. Initial blast of air (decompression) from the air dryer purge valve at the beginning of the unload cycle of the air compressor

_______ c. Period required for the air compressor to fully pressurize the air brake system

_______ d. Pit or reservoir serving as a drain or receptacle for liquids

_______ e. Time during which the air compressor is building air pressure in the air system

_______ f. Backflow of air from the air system and through the air dryer to remove moisture and to ready the air dryer for the next compressor load cycle

_______ g. Granular substance used to remove moisture from the air stream flowing through the air dryer

_______ h. Pressure level in the air system supply reservoir that triggers the compressor load cycle

_______ i. Small solid contaminant such as dust and road grit

_______ j. Rate at which a compressor produces pressurized air; usually measured as air flow in cubic feet per minute (cfm)

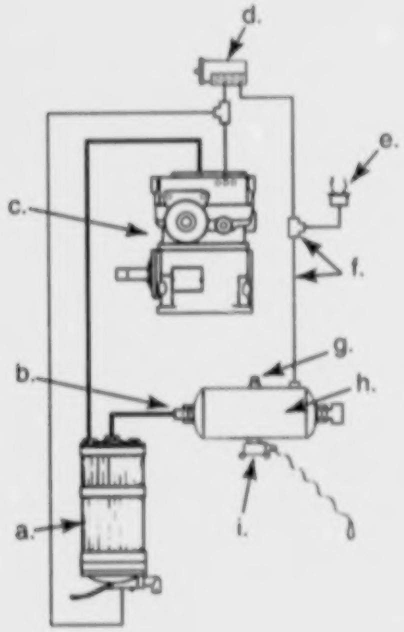
_______ k. Time during which the air compressor is idling and is not building air pressure in the air system

_______ l. Formed as a unit with another part

1. Build-up time
2. Compressor output
3. Cut-in pressure
4. Cut-out pressure
5. Desiccant
6. Integral
7. Load cycle
8. Particulate
9. Purge
10. Regeneration
11. Remote
12. Sump
13. Unload cycle
14. Valve

## Written Test

2. Identify the components of the air supply system. Write your answers in the blanks below.



Courtesy of Haldex Midland Services

a. ______________________ b. ______________________

c. ______________________ d. ______________________

e. ______________________ f. ______________________

g. ______________________ h. ______________________

i. ______________________

## Written Test

3. Match air supply system components on the right with their basic functions.

_______ a. Connect brake components so air is not lost from system

_______ b. Direct, control, and monitor various qualities of the air in the supply system such as pressure level and flow direction

_______ c. Pumps air to and builds air pressure in an air system

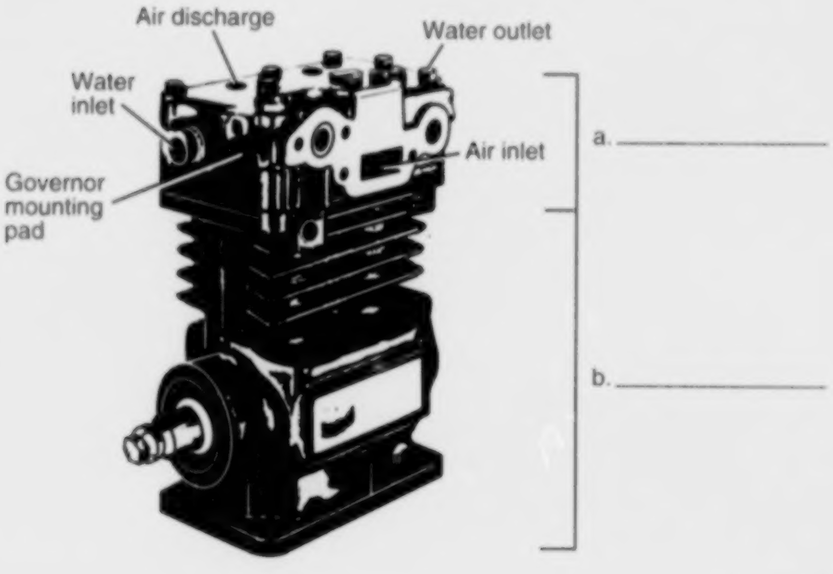
_______ d. Cools, filters, and removes moisture, oil, and other contaminants from the air delivered by the compressor

_______ e. Holds pressurized air for transfer to the service reservoirs

_______ f. Controls operation of the compressor so that air pressure is maintained between a maximum and minimum pressure level; also controls operation of air dryer

1. Air brake lines and fittings
2. Air dryer
3. Compressor
4. Governor
5. Supply reservoir
6. Valves and switches

4. Label the main parts of a compressor. Write your answers in the blanks provided on the illustration.



Courtesy of AlliedSignal Bendix

## Written Test

5. Complete the following statements concerning the characteristics of compressors by filling in the blanks with the correct answers.

   a. Supply and maintain ______________________________ to the air brake system and/or auxiliary air systems

   b. Are driven by the vehicle's engine using a ______________ or a ____________

   c. Operate continuously while the engine is running, but only compress air when actuated by the __________________________

   d. May be base mounted or ______________________ mounted

6. Select true statements concerning the loading and unloading process by placing an "X" next to the true statements.

   a. Loading process:

      _____ 1) During the down stroke of the piston, the inlet valve opens and atmospheric air is drawn into the cylinder.

      _____ 2) As the piston begins its upward stroke, the air that was drawn into the cylinder is being filtered.

      _____ 3) Then the inlet valve closes and the discharge valve opens which allows air to flow into the discharge line and to the reservoirs.

      _____ 4) As the piston starts down, the discharge valve closes which prevents the contaminated air from returning.

   b. Unloading process:

      _____ 1) When air pressure in the reservoir reaches the cut-out setting of the governor, the governor allows air to pass from the reservoir, through the governor, and into the cavity below the unloader pistons.

      _____ 2) As the unloader pistons move down and hold the inlet valves off their seats, air is pumped back and forth between the two cylinders, and the discharge valves remain closed.

      _____ 3) When air pressure from the reservoir drops to the cut-in setting of the governor, the governor closes and exhausts the air from above the unloader pistons. The unloader springs force the pistons upward and the inlet valves return to their seats. Compression can then resume.

7. Complete the following statements concerning the characteristics of governors by circling the correct answers.

   a. Constantly monitor the air pressure in the **(air dryer, supply reservoir)** and automatically control the operation of the **(reservoir drain valve, air compressor)**

   b. Initiate the compressor load cycle when **(cut-in, cut-out)** pressure is realized, and initiate the compressor unload cycle when the **(cut-in, cut-out)** pressure is reached

c. Also control the air dryer by sending an air signal to the **(control, exhaust)** port of the air dryer, initiating the purge cycle; when this air signal is removed by the governor, the purge valve closes and the drying cycle begins

d. May be remote mounted or direct flange mounted on the **(compressor, air dryer)**

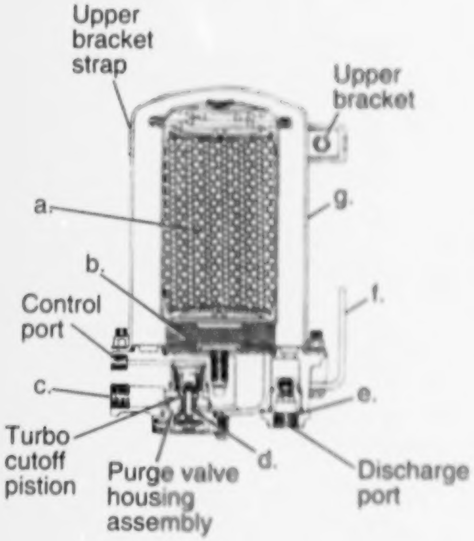
8. Distinguish among the the methods of providing clean air to the compressor by placing an "X" next to the pressurized induction method(s).

_______ a. Compressor inlet is connected to the engine air cleaner or the vacuum side of the supercharger or turbocharger.

_______ b. Compressor inlet is connected to the pressure side of the supercharger or turbocharger.

_______ c. Compressor uses its own attached air strainer which is typically made of polyurethane sponge or pleated paper dry element.

9. Identify the parts and ports of an air dryer. Write your answers in the blanks provided.


Upper bracket strap
Upper bracket
a.
g.
b.
f.
Control port
c.
e.
Turbo cutoff pistion
Purge valve housing assembly
d.
Discharge port

Courtesy of AlliedSignal Bendix

a. ______________________ b. ______________________

c. ______________________ d. ______________________

e. ______________________ f. ______________________

g. ______________________

## Written Test

10. Complete the following statements concerning the characteristics of air dryers by filling in the blanks with the correct answers.

    a. Provide ______________________________ to reservoirs, valves, and other components

    b. One common design is the ______________________________ type.

    c. Many designs also include a replaceable heater and thermostat assembly to prevent

    ______________________________________________________ prior to its exhaust.

11. Distinguish between cycles that occur in the operation of the air dryer by placing a "D" for drying cycle next to its descriptions.

    _______ a. Occurs when the air system reaches governor cut-out setting

    _______ b. Occurs when the air system reaches governor cut-in setting

    _______ c. Occurs when the compressor is loading

    _______ d. Occurs when the compressor is unloading

12. Distinguish between optional devices that may be used on supply systems by placing an "X" next to aftercooler descriptions.

    _______ a. May be used on some systems that do not have an air dryer

    _______ b. Is installed between the compressor and the supply reservoir

    _______ c. Condenses and eliminates water from pressurized (compressed) air

    _______ d. Operates by injecting alcohol mist into the air flow to reduce the risk of freeze-up by lowering the freezing temperature of water

13. Complete the following statements concerning the characteristics of supply reservoirs by filling in the blanks with the correct answers.

    a. Hold pressurized and conditioned ______________________________.

    b. As the air in the reservoir cools, water and ____________________ collect in the reservoir.

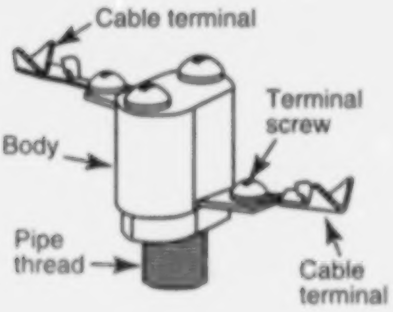
    c. Reservoirs must be drained at least once a __________________________, unless the vehicle is equipped with an automatic drain valve which operates each time the brakes are applied.

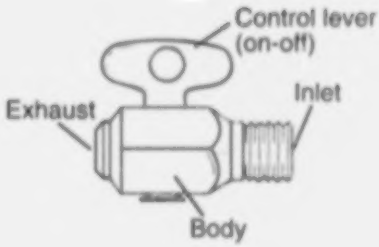
    d. The supply reservoir is the first tank after the ______________________________________.

    e. The supply reservoir is sometimes called the "______________________ tank."

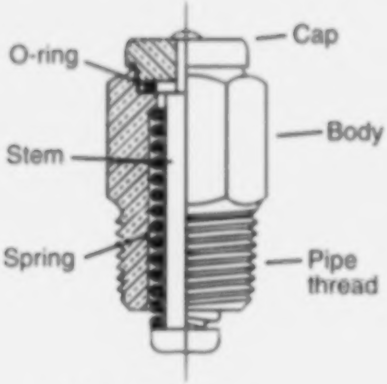
## Written Test

14. Identify valves and switches used on the air supply system. Write your answers in the blanks below.

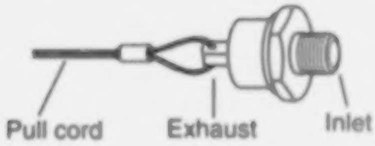

Cable terminal
Terminal screw
Body
Pipe thread
Cable terminal


Control lever (on-off)
Inlet
Exhaust
Body

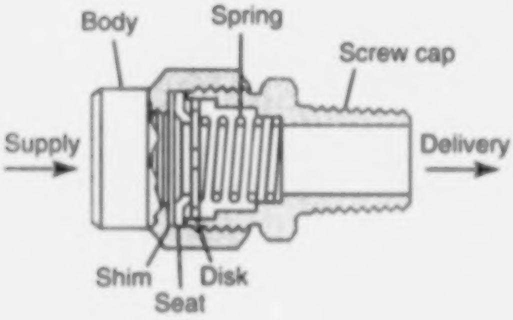
a. ______________________ b. ______________________


O-ring
Cap
Body
Stem
Spring
Pipe thread

Courtesy of Freightliner Corporation

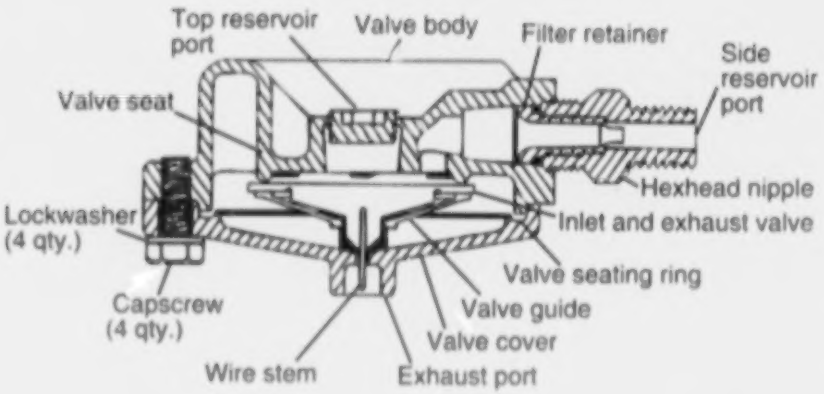

Pull cord
Exhaust
Inlet

c. ______________________ d. ______________________


Body
Spring
Screw cap
Supply
Delivery
Shim
Seat
Disk

Courtesy of Freightliner Corporation

e. ______________________


Top reservoir port
Valve body
Filter retainer
Side reservoir port
Valve seat
Hexhead nipple
Lockwasher (4 qty.)
Inlet and exhaust valve
Valve seating ring
Capscrew (4 qty.)
Valve guide
Valve cover
Wire stem
Exhaust port

f. ______________________________

Courtesy of Freightliner Corporation

15. Match supply system valves and switches on the right with their functions.

_______ a. Permits removal of condensate from reservoir; may be manual or automatic; may also be electrically heated to prevent valve from freezing open or closed

_______ b. Releases air at excessive pressures; "pops off" when limit is reached

_______ c. Allows air to flow in only one direction

1. Drain valve
2. Low pressure switch
3. Safety valve
4. Single check valve (one way)

16. Complete the following statements concerning the basic characteristics of air brake valves by filling in the blanks with the correct answers.

a. All air brake valves have air passages and ______________________________.

b. As the valve's internal parts move, they direct the ______________________________ to the desired location.

c. Each air valve has at least one ______________________________ port to allow air to exit the valve.

d. Some air valves may have a(n) ______________________________ port that allows air to vent to the atmosphere.

e. Manual valves require the driver to move a knob, handle, or ______________________________ to work the valve.

f. Automatic valves use ______________________________ ports or internal regulating parts to work.

## Written Test

17. Distinguish among the types of lines used on the air supply system by placing the following letters next to the correct descriptions:

- RH—Reinforced hose
- MT—Metal tubing
- NT—Nylon tubing

_______ a. Commonly used for standard service and supply lines to connect components throughout the system

_______ b. Commonly made of fabric and rubber; may be lined with Teflon or covered with steel braid

_______ c. Used for high heat applications

_______ d. Should not be used in high heat areas

_______ e. Commonly found between the compressor and the next component

_______ f. Typically used where more flexibility is needed such as when going to the air brake chambers or for trailer connections

_______ g. May be color coded for system identification

Permission to duplicate this test is granted.

## Air Supply System
## Unit 2-C

### Answers to Written Test

1. a. 4
   b. 9
   c. 1
   d. 12
   e. 7
   f. 10
   g. 5
   h. 3
   i. 8
   j. 2
   k. 13
   l. 6

2. a. Air dryer
   b. Check valve
   c. Compressor
   d. Governor
   e. Low pressure switch
   f. Air lines and fittings
   g. Safety valve
   h. Supply reservoir
   i. Drain valve (automatic)

3. a. 1
   b. 6
   c. 3
   d. 2
   e. 5
   f. 4

4. a Cylinder head
   b. Crankcase

5. a. Pressurized (compressed) air
   b. Belt, gear
   c. Governor
   d. Flange

6. a. 1 3
   b. 2, 3

7. a. Supply reservoir, air compressor
   b. Cut-in, cut-out
   c. Control
   d. Compressor

8. b

9. a. Desiccant bed
   b. Oil separator
   c. Supply port
   d. Purge valve
   e. Check valve assembly
   f. Lower bracket
   g. Housing

10. a. Clean, dry air
    b. Desiccant or heat exchanger (either answer)
    c. Freezing of accumulated condensate

## Answers to Written Test

11. b, c

12. a, b, c

13.
    - a. Air
    - b. Contaminants
    - c. Day
    - d. Compressor
    - e. Wet

14.
    - a. Low pressure switch
    - b. Manual drain valve (drain cock)
    - c. Safety valve (pressure relief)
    - d. Manual drain valve (pull chain)
    - e. Single check valve (one way)
    - f. Automatic drain valve

15.
    - a. 1
    - b. 3
    - c. 4

16.
    - a. Internal moving parts
    - b. Compressed air
    - c. Delivery
    - d. Exhaust
    - e. Pedal
    - f. Control

17.
    - a. NT
    - b. RH
    - c. MT
    - d. NT (or RH)
    - e. MT
    - f. RH
    - g. NT

# Air Supply System
# Unit 2-C

## Unit Evaluation Form

Student Name ______________________ Unit Rating __________

Assignment Sheet 1—Identify and Connect Components in an Air Supply System Rating ______

Comments: ______________________________

______________________________

Job Sheet 1—Service the Reservoir and Check Valve Function, Build-Up Time, and Cut-Out Pressure Rating ______

Comments: ______________________________

______________________________

Job Sheet 2—Inspect and Service Belt-Driven Compressor and Associated Lines Rating ______

Comments: ______________________________

______________________________

Job Sheet 3—Inspect, Service, and Time Gear-Driven Compressor, Valves, and Associated Lines Rating ______

Comments: ______________________________

______________________________

Job Sheet 4—Inspect and Service Air Dryer System; Repair or Replace as Needed Rating ______

Comments: ______________________________

______________________________

**Written Test Scores**

Pretest ________ Posttest ________ Other ________

Other ______________________________

______________________________

**Teacher Signature** ______________________ Date __________

**Student Signature** ______________________ Date __________

Permission to duplicate this form is granted.

# Air Service Circuits
# Unit 3-C

## Unit Contents

**Teacher Components** **Teacher Page**

1. Suggested Activities
    - a. Instructional Plan .1
    - b. Teaching Suggestions .2
    - c. Resources Used in Developing This Unit .2
    - d. Suggested Supplemental Resource .3
    - e. Instructions for Evaluating Student Performance .3
2. Transparency Masters
    - 1—Components of the Secondary Service Circuit .5
    - 2—Components of the Primary Service Circuit .7
    - 3—Treadle and Brake Application Valves .9
    - 4—Cross Section of Brake Application Valve .11
    - 5—Parts and Ports of a Quick Release Valve .13
    - 6—Parts and Ports of a Relay Valve .15
3. Answers to Assignment Sheet 1 .17
4. Written Test .19
5. Answers to Written Test .27
6. Unit Evaluation Form .29

**Student Components** **Student Page**

DT:B

1. Objective Sheet .C-85
2. Information Sheet .C-87
3. Assignment Sheet
    - 1—Identify and Connect Components in the Air Service Circuits .C-95
4. Job Sheets
    - 1—Inspect and Test Brake Application (Foot) Valve, Fittings, and Mounts; Adjust or Replace as Needed .C-97
    - 2—Inspect and Test Stop Light Circuit Switches, Wiring, and Connectors; Repair or Replace as Needed .C-103
    - 3—Inspect and Test Relay Valve; Replace as Needed .C-107
    - 4—Inspect and Test Quick Release Valve; Replace as Needed .C-111

# Air Service Circuits
# Unit 3-C

## Suggested Activities

### Instructional Plan

### Preparation

1. Read the unit carefully and plan for instruction.
2. Review "Teaching Suggestions." Plan for classroom activities.
3. Plan for students with special needs.
4. Obtain videotapes, service manuals, and other resources to supplement instruction of this unit. See "Resources" for more information.
5. Make transparencies from the transparency masters included in this unit.
6. Develop teaching plan. Adjust for different learning styles.
7. Review "Instructions for Evaluating Student Performance."
8. Make copies of the Unit Evaluation Form, one for each student.

### Delivery and Application

9. Provide students with unit of instruction.
10. Discuss unit and specific objectives.
11. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
12. Discuss the assignment sheet. Review criteria for evaluation of this activity.
13. Discuss and demonstrate the job sheets. Make sure all required tools, equipment, and supplies are available. Review criteria for evaluation of these activities.

### Evaluation

14. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.
15. Make copies of the written test. Add or modify test items as needed.
16. Give written test.
17. Compile assignment sheet rating, job sheet ratings, and written test scores on the Unit Evaluation Form. Add any additional assignments or supplemental activities that should be part of the unit evaluation.
18. Reteach and retest as required.

## Suggested Activities

### Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A Report for America 2000* and *Workplace Basics: The Skills Employers Want.* These have been adapted by MAVCC.

1. Discuss what the term "service circuit" means.
2. Distinguish between primary and secondary circuits, and discuss reasons for having split systems. Emphasize that most diesel trucks use a front-rear system split, but point out that other methods of splitting the brake system are sometimes used. **(Thinking Skills—Reasoning)**
3. Show examples of primary and secondary circuits, and use flow diagrams to show how they function as part of the braking system. Have students compare the two circuits. **(Thinking Skills—Reasoning; Systems—Interrelationships)**
4. Provide examples of the various types of valves and discuss their roles in service circuits. Include two-way check valves and discuss their role in the air brake system. Have students practice identifying them. **(Thinking Skills—Reasoning)**
5. Have students examine actual vehicles with a variety of primary and secondary circuit configurations and identify the components on the vehicles. **(Thinking Skills—Reasoning and problem solving)**
6. Make a display of worn and damaged valves. Have students practice inspecting parts for damage. **(Thinking Skills—Problem solving; Technology—Troubleshooting)**
7. Discuss regulatory requirements for stop light switches. **(Thinking Skills—Reasoning)**
8. Discuss the most common problems with air service circuits and explain how these problems affected the vehicle's performance. **(Thinking Skills—Problem solving; Technology—Troubleshooting)**
9. Demonstrate and discuss preventative maintenance procedures for air service circuits. Discuss the cost for replacing parts and the importance of failure analysis of faulty parts to prevent costly repairs. **(Thinking Skills—Problem solving; Resources—Time and money; Technology—Maintenance and troubleshooting)**
10. Discuss safety precautions to follow when working on air service circuits. **(Personal Management Skills—Responsibility and organizational effectiveness [value of safety])**

### Resources Used in Developing This Unit

1. *The Air Brake Book*, 5th revised ed. Radnor, PA: Commercial Carrier Journal.
2. *Air Brake Handbook*. Elyria, OH: AlliedSignal Automotive, Truck Brake Systems Company, 1995.
3. *Air Brake System*. Allentown, PA: Mack Trucks, 1986
4. *Grey-Rock Heavy Duty Brake Service Manual*. Owosso, MI: Grey-Rock, 1983.
5. Norman, Ian Andrew et al. *Heavy Duty Truck Systems*, 2nd ed. Albany, NY: Delmar Publishers, Inc., 1996.

6. Schultz, Erich J. *Diesel Equipment I: Lubrication, Hydraulics, Brakes, Wheels, Tires.* Lake Forest, IL: Glencoe Division of Macmillan/McGraw-Hill Publishing Company, 1991.

7. *Workbook and Learning Aid for Air Brake Systems.* Kansas City, MO: Midland-Grau Heavy Duty Systems, 1991.

## Suggested Supplemental Resource

1. Service Brake System, Part 2, BW 1675, VHS training video. Available from:

   AlliedSignal Truck Brake Systems Co.
   901 Cleveland Street
   P.O. Box 4016
   Elyria, OH 44036-2016
   1-216-329-9000

## Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

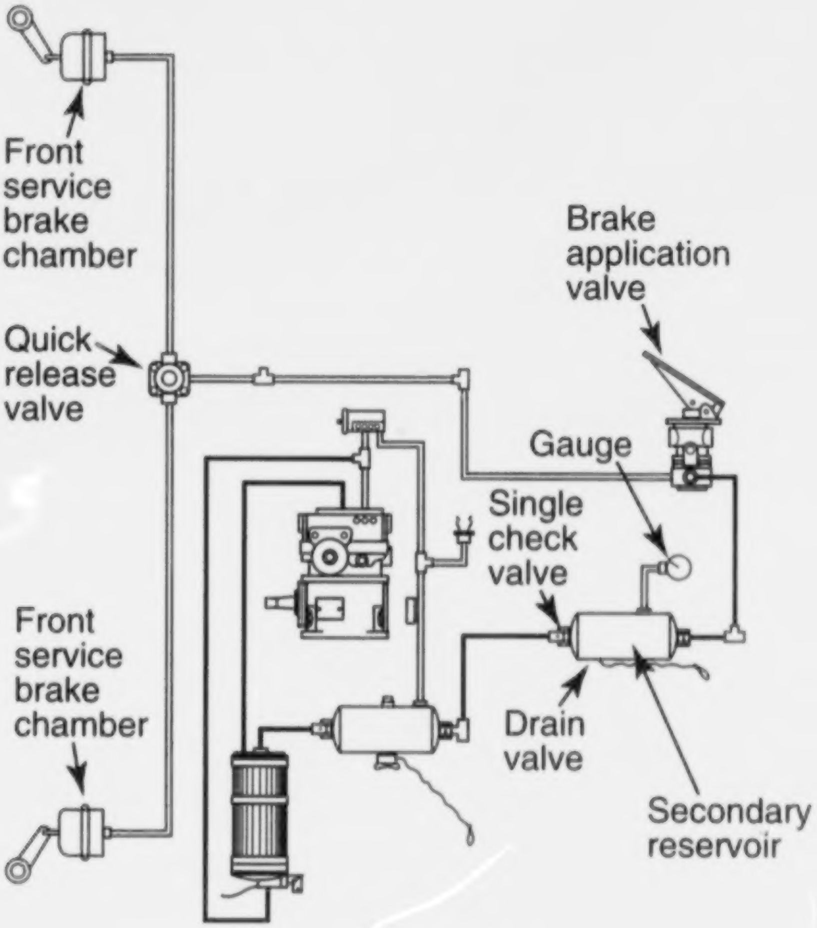
Option B

Yes—Can perform job with no additional training.

No—Is unable to perform job satisfactorily.

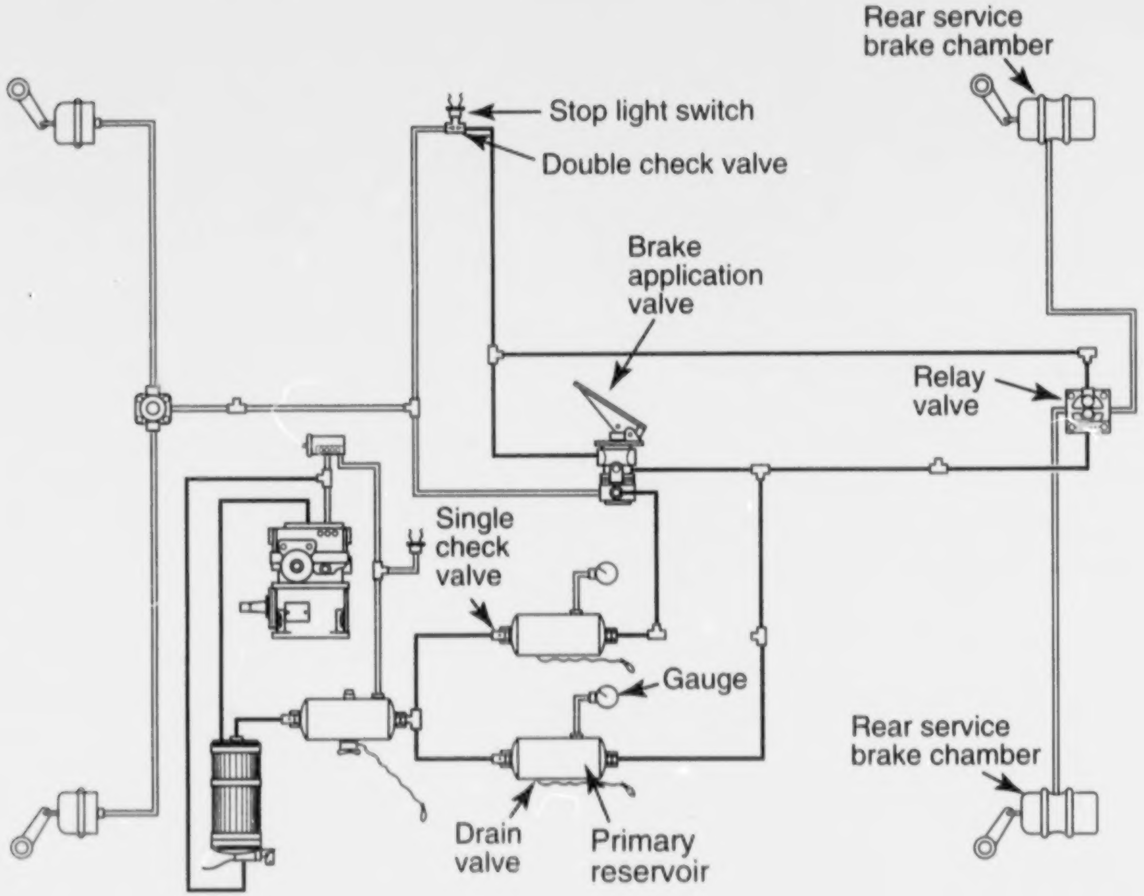
240

# Components of the Secondary Service Circuit


Front service brake chamber
Brake application valve
Quick release valve
Gauge
Single check valve
Front service brake chamber
Drain valve
Secondary reservoir

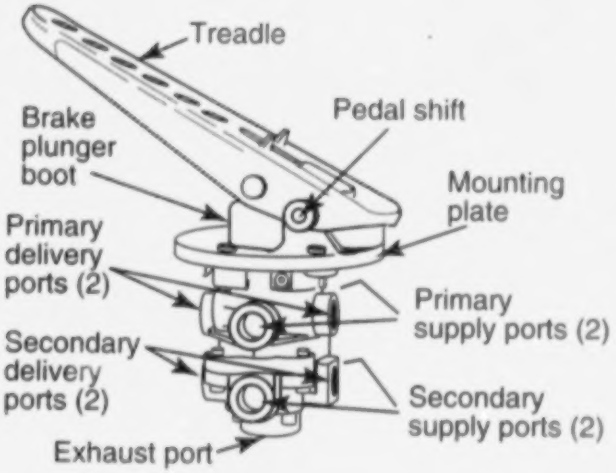
Courtesy of Haldex Midland Services

# Components of the Primary Service Circuit

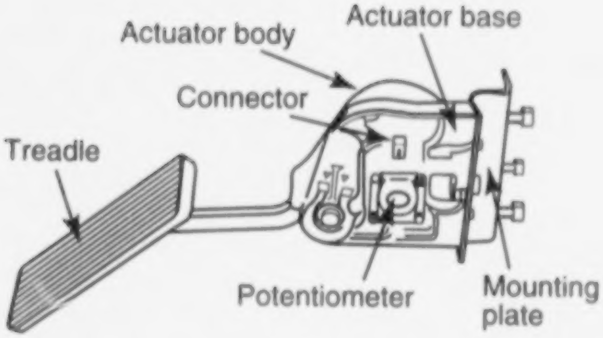

Rear service brake chamber
Stop light switch
Double check valve
Brake application valve
Relay valve
Single check valve
Gauge
Rear service brake chamber
Drain valve
Primary reservoir

Courtesy of Haldex Midland Services

# Treadle and Brake Application Valves


Treadle
Brake plunger boot
Pedal shift
Mounting plate
Primary delivery ports (2)
Primary supply ports (2)
Secondary delivery ports (2)
Secondary supply ports (2)
Exhaust port

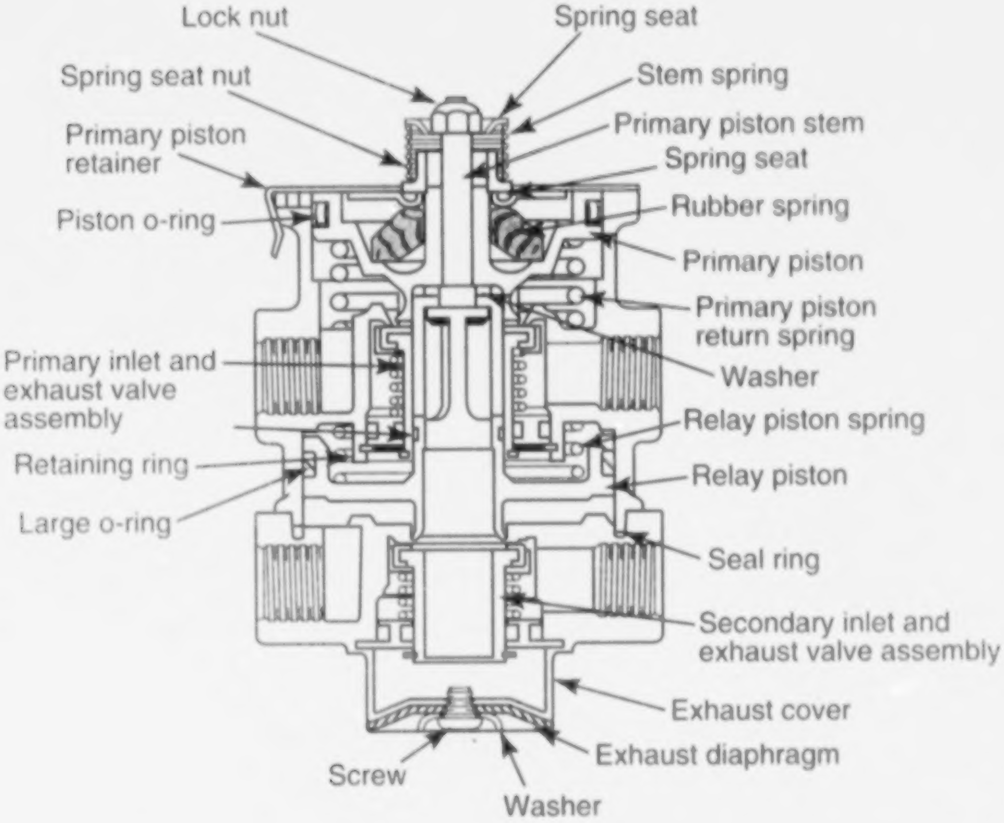
**Mechanical**


Actuator body
Actuator base
Connector
Treadle
Potentiometer
Mounting plate

**Electronic**

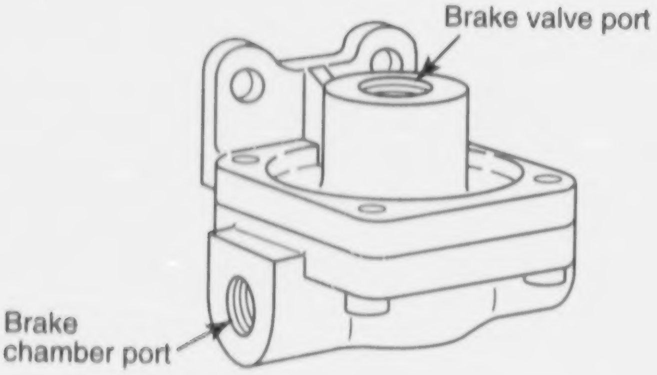
Courtesy of AlliedSignal Bendix

# Cross Section of Brake Application Valve


Lock nut
Spring seat
Spring seat nut
Stem spring
Primary piston retainer
Primary piston stem
Spring seat
Piston o-ring
Rubber spring
Primary piston
Primary piston return spring
Primary inlet and exhaust valve assembly
Washer
Relay piston spring
Retaining ring
Relay piston
Large o-ring
Seal ring
Secondary inlet and exhaust valve assembly
Exhaust cover
Exhaust diaphragm
Screw
Washer

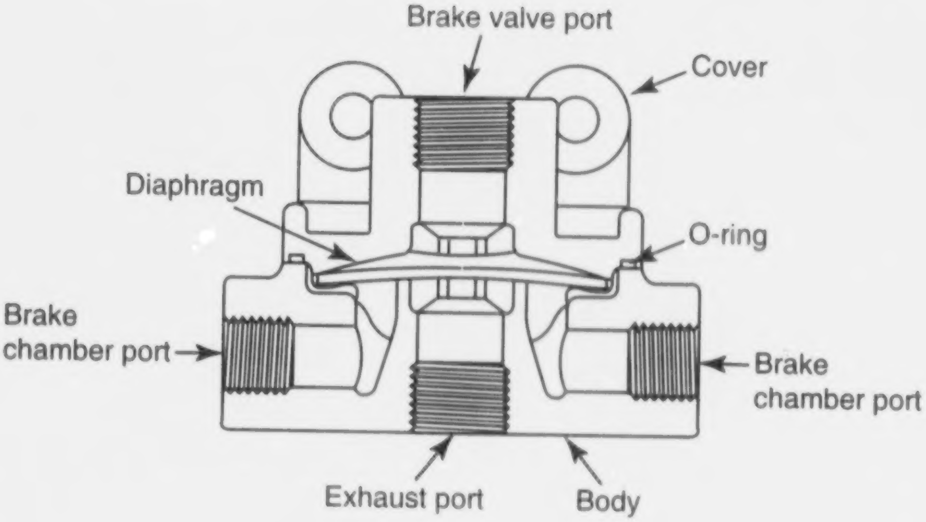
Courtesy of AlliedSignal Bendix

# Parts and Ports of a Quick Release Valve


Brake valve port
Brake chamber port

**Exterior View**

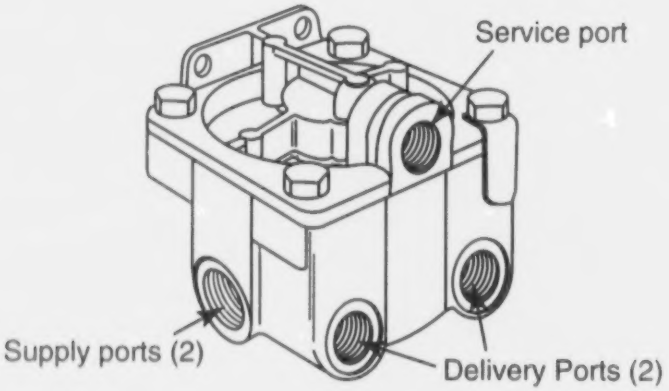
Courtesy of AlliedSignal Bendix


Brake valve port
Cover
Diaphragm
O-ring
Brake chamber port
Brake chamber port
Exhaust port
Body

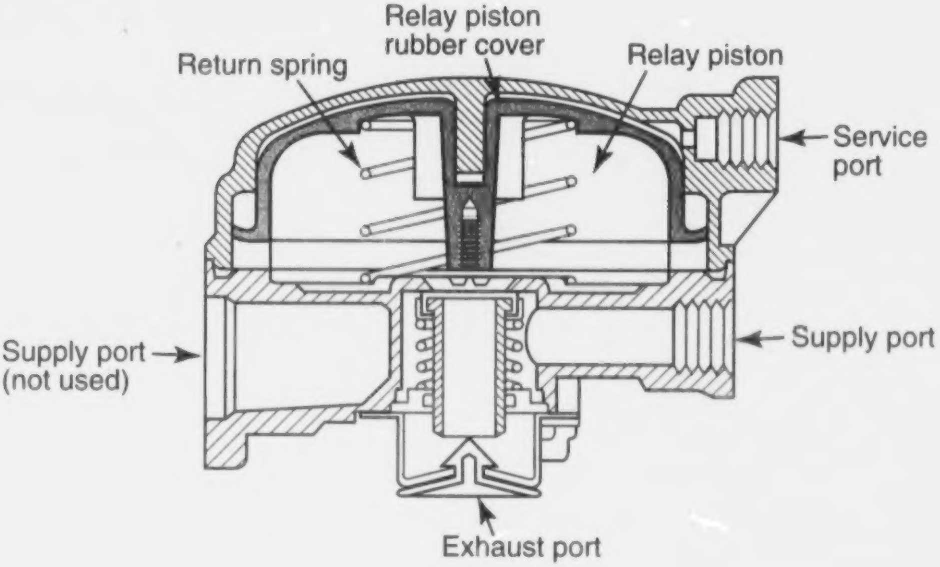
**Cross Section View**

Courtesy of Freightliner Corporation

# Parts and Ports of a Relay Valve


Service port
Supply ports (2)
Delivery Ports (2)

Exterior View

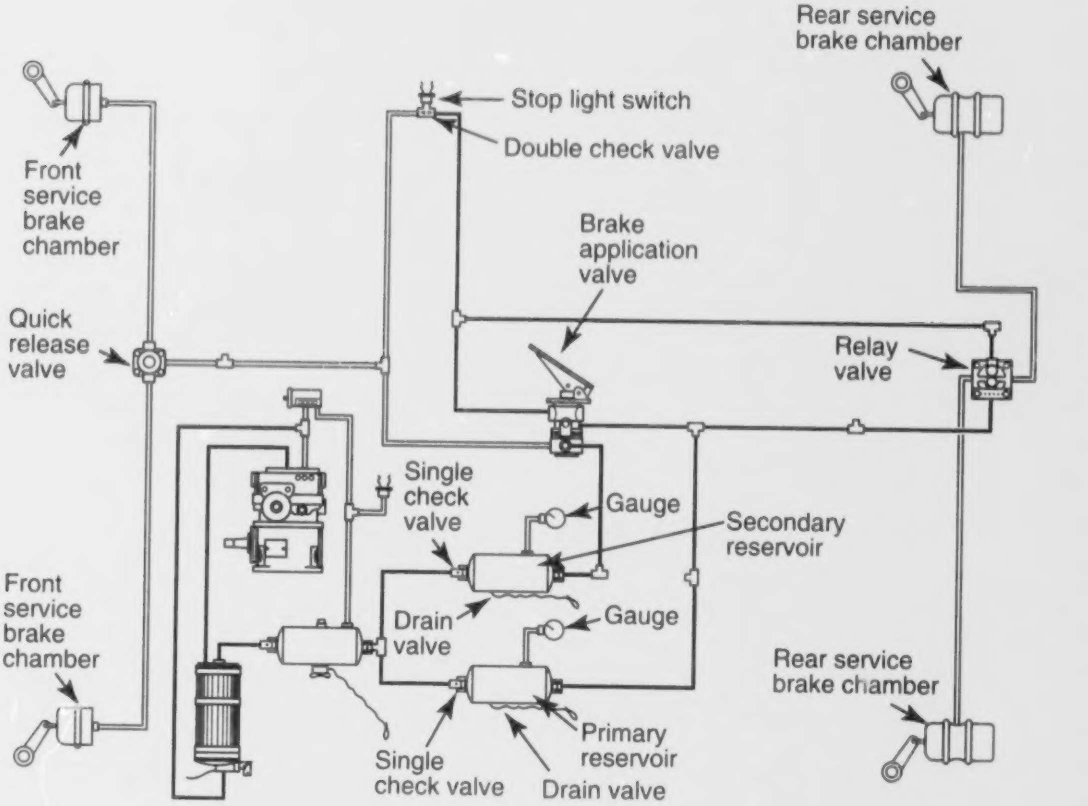

Relay piston rubber cover
Return spring
Relay piston
Service port
Supply port (not used)
Supply port
Exhaust port

Cross Section View

Courtesy of Freightliner Corporation

# Air Service Circuits
# Unit 3-C

## Answers to Assignment Sheet 1


Rear service brake chamber
Stop light switch
Double check valve
Front service brake chamber
Brake application valve
Quick release valve
Relay valve
Single check valve
Gauge
Secondary reservoir
Front service brake chamber
Drain valve
Gauge
Rear service brake chamber
Primary reservoir
Single check valve
Drain valve

Courtesy of Haldex Midland Services

# Air Service Circuits
# Unit 3-C

## Written Test

Name ______________________ Date __________ Score __________

1. Match the terms on the right with the correct definitions.

_______ a. Device actuated by variations in conditions that in turn sends that message on to other devices in the same or different circuit

_______ b. To adjust by graduations

_______ c. Complete path of a system

_______ d. Safety feature that prevents the total loss of braking in the event of a failure in one circuit

_______ e. Variable resistor that may be used to operate electronic components

_______ f. Swiveling or lever device operated by the foot that is used to apply the brakes

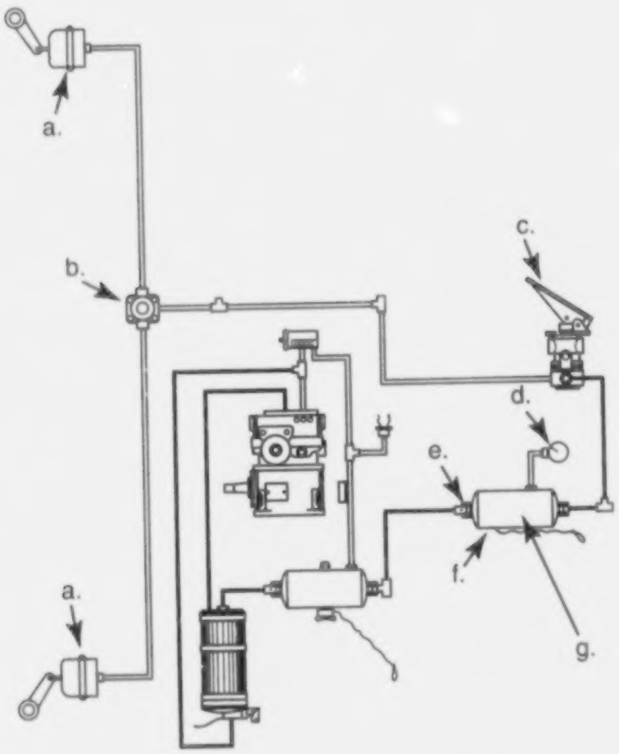
1. Circuit
2. Dual circuit
3. Modulate
4. Potentiometer
5. Relay
6. Treadle

2. Compare the secondary and primary service circuits by filling in the blanks with the correct answers.

| DIFFERENCES | SIMILARITIES |
|---|---|
| a. Secondary service circuit serves the __________brake service chambers. | f. Both systems receive pressurized air from the ______________. |
| b. Primary service circuit serves the __________brake service chambers. | g. Each reservoir is similar and requires a ______________ to control and monitor its operation. |
| c. Secondary service circuit uses a __________ valve. | h. Both circuits are served by one _____ ____________________ valve. |
| d. Primary service circuit uses a __________valve. | i. Either circuit can service the _______. |
| e. ____________ service circuit also includes the stop light switch and double check valve. | |

## Written Test

3. Identify the components of the secondary service circuit. Write your answers in the blanks below.



Courtesy of Haldex Midland Services

a. ______________________________________________

b. ______________________________________________

c. ______________________________________________

d. ______________________________________________

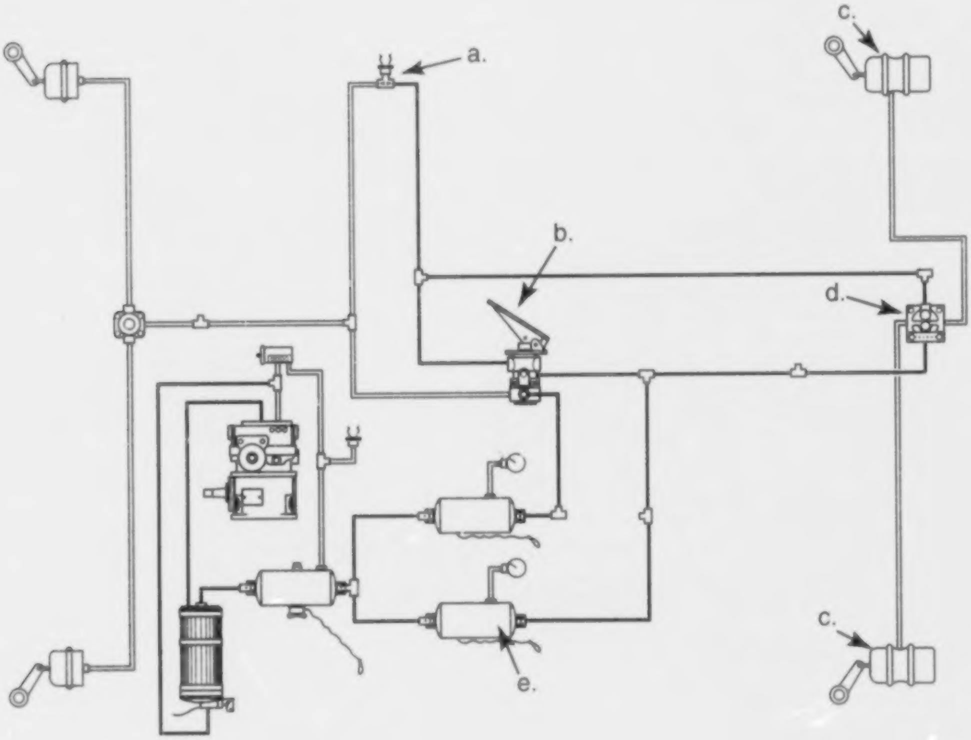
e. ______________________________________________

f. ______________________________________________

g. ______________________________________________

## Written Test

4. Identify the components of the primary service circuit. Write your answers in the blanks below.



Courtesy of Haldex Midland Services

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

## Written Test

5. Match service circuit components on the right with their functions.

_______ a. Seeks out the dominant air pressure from two sources and delivers it, as in this case to the stop light switch

_______ b. Hold pressurized air from the supply system for use by the service systems

_______ c. Functions as a remote station to speed up the application and release of the brakes; is mounted at the rear of the vehicle close to the chambers it serves

_______ d. Indicate air pressure of service reservoirs

_______ e. Activates exterior brake lights when brakes are applied

_______ f. Convert air pressure to mechanical force that is used to apply the foundation brakes

_______ g. Modulates the application of the service brakes by controlling the delivery of air to the service brake chambers; separates the primary and secondary service circuits so in case of a failure of one circuit, the other is still functional

_______ h. Allows faster exhaustion of air from front service chambers

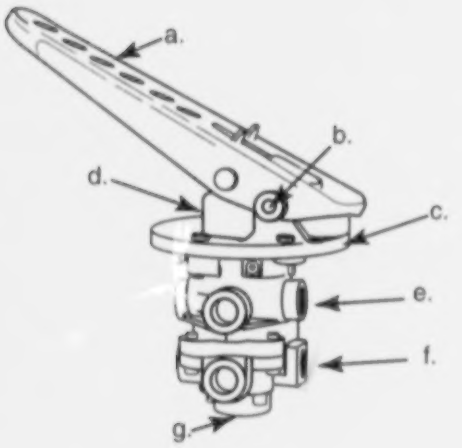
_______ i. Allow air to flow only one direction and thereby prevent the backflow of air into the supply reservoir

1. Air pressure gauges
2. Brake application (foot) valve (dual)
3. Double (two-way) check valve
4. Drain valves
5. Quick release valve
6. Relay valve
7. Service brake chambers (front and rear)
8. Service reservoirs (secondary and primary)
9. Single (one-way) check valves
10. Stop light switch

## Written Test

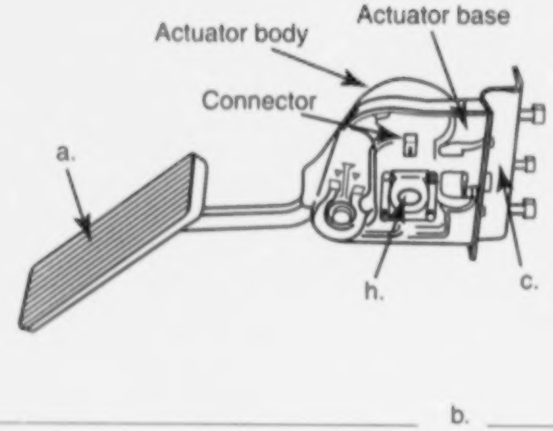
6. Identify the parts of a brake application valve and treadle assembly. Write your answers in the blanks below.

   - Mechanical treadle



Courtesy of AlliedSignal Bendix

   - Electronic treadle


Actuator body
Actuator base
Connector
a.
h.
c.

Courtesy of AlliedSignal Bendix

a. ______________________ b. ______________________

c. ______________________ d. ______________________

e. ______________________ f. ______________________

g. ______________________ h. ______________________

## Written Test

7. Complete the following statements concerning the characteristics of the brake application valve by circling the correct answers.

   a. May be cab **(dash-mounted, floor-mounted)** or engine firewall-mounted and suspended

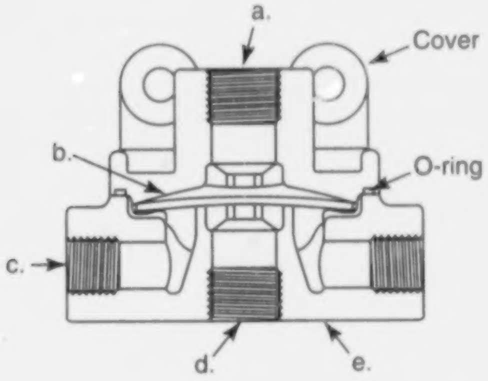
   b. Mechanical brake application valves transmit mechanical force to the engine **(governor, exhaust valves)**.

   c. Electronic treadles supply a variable electrical voltage to the engine's **(electronic controller, exhaust sensors)**.

   d. **(Single circuit, Dual circuit)** valves use two separate supply and delivery circuits for primary and secondary braking.

   e. **(Single circuit, Dual circuit)** valves may be seen on older equipment.

8. Identify the parts and ports of a quick release valve. Write your answers in the blanks below.



Courtesy of Freightliner Corporation

a. ____________________________________________

b. ____________________________________________

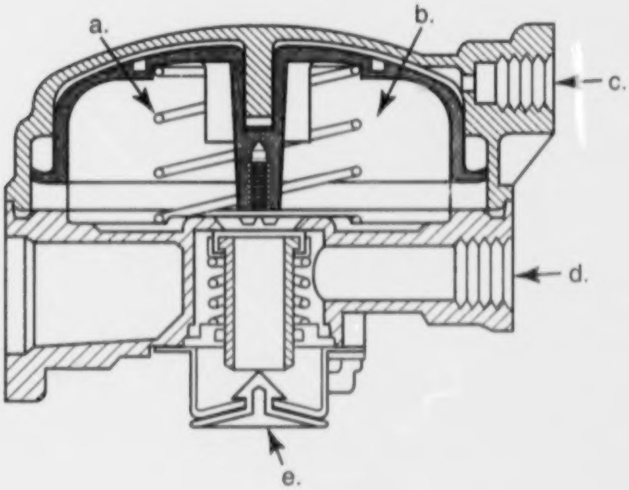
c. ____________________________________________

d. ____________________________________________

e. ____________________________________________

## Written Test

9. Identify the parts and ports of a relay valve. Write your answers in the blanks below.



Courtesy of Freightliner Corporation

a. ________________________________________

b. ________________________________________

c. ________________________________________

d. ________________________________________

e. ________________________________________

10. Match other valves that may be used on service circuits on the right with their descriptions.

_______ a. Is used on vehicles with air accessories

_______ b. Only used on tractor applications

_______ c. Allows full front wheel braking only under extreme braking pressures

_______ d. Reduces air pressure to the rear service brake chambers when the tractor is not towing a trailer

_______ e. Automatically limits air pressure to the front service brake chambers

_______ f. Protects the air supply to the brakes if a failure occurs in the accessory equipment

1. Front axle limiting (ratio) valve
2. Proportioning (ratio) valve
3. Pressure protection valve

Permission to duplicate this test is granted.

# Air Service Circuits
## Unit 3-C

### Answers to Written Test

1. a. 5
   b. 3
   c. 1
   d. 2
   e. 4
   f. 6

2. a. Front
   b. Rear
   c. Quick release
   d. Relay
   e. Primary
   f. Supply reservoir
   g. Any one of the following:
      - Check valve
      - Drain valve
      - Air pressure gauge
   h. Brake application (foot)
   i. Trailer

3. a. Front service brake chamber
   b. Quick release valve
   c. Brake application valve
   d. Gauge
   e. Single check valve
   f. Drain valve
   g. Secondary reservoir

4. a Stop light switch
   b. Brake application valve
   c. Rear service brake chamber
   d. Relay valve
   e. Primary reservoir

5. a. 3
   b. 8
   c. 6
   d. 1
   e. 10
   f. 7
   g. 2
   h. 5
   i. 9

6. a. Treadle
   b. Pedal shift
   c. Mounting plate
   d. Brake plunger boot
   e. Primary supply port
   f. Secondary supply port
   g. Exhaust port
   h. Potentiometer

7. a. Floor-mounted
   b. Governor
   c. Electronic controller
   d. Dual circuit
   e. Single circuit

## Answers to Written Test

8. a. Brake valve port (supply)
   b. Diaphragm
   c. Brake chamber port (delivery)
   d. Exhaust port
   e. Body

9. a. Return spring
   b. Relay piston
   c. Service port (delivery)
   d. Supply port
   e. Exhaust port

10. a. 3
    b. 2
    c. 1
    d. 2
    e. 1
    f. 3

# Air Service Circuits
# Unit 3-C

## Unit Evaluation Form

Student Name ______________________________ Unit Rating ____________

Assignment Sheet 1—Identify and Connect Components in the Air Service Circuits Rating ______

Comments: ______________________________

______________________________

Job Sheet 1—Inspect and Test Brake Application (Foot) Valve, Fittings, and Mounts; Adjust or Replace as Needed Rating ______

Comments: ______________________________

______________________________

Job Sheet 2—Inspect and Test Stop Light Circuit Switches, Wiring, and Connectors; Repair or Replace as Needed Rating ______

Comments: ______________________________

______________________________

Job Sheet 3—Inspect and Test Relay Valve; Replace as Needed Rating ______

Comments: ______________________________

______________________________

Job Sheet 4—Inspect and Test Quick Release Valve; Replace as Needed Rating ______

Comments: ______________________________

______________________________

**Written Test Scores**

Pretest ________ Posttest ________ Other ________

Other ______________________________

______________________________

**Teacher Signature** ______________________ Date ____________

**Student Signature** ______________________ Date ____________

Permission to duplicate this form is granted.

# Special Circuits
# Unit 4-C

## Unit Contents

**Teacher Components** **Teacher Page**

1. Suggested Activities

a. Instructional Plan ....... 1
b. Teaching Suggestions ....... 2
c. Resources Used in Developing This Unit ....... 2
d. Suggested Supplemental Resource ....... 3
e. Instructions for Evaluating Student Performance ....... 3

2. Transparency Masters

1—Components of the Parking Circuit ....... 5
2—Components of the Emergency Circuit ....... 7
3—Components of the Anti-Compounding Circuit ....... 9
4—Typical Truck Brake System ....... 11
5—Parts and Ports of a System Park Control Valve ....... 13
6—Ports of an Inversion Valve ....... 15
7—Parts and Ports of a Spring Brake (Rear Axles) ....... 17
8—Operation of Spring Brakes ....... 19
9—Typical Tractor Brake System ....... 21
10—Parts of a Hand Control Valve ....... 23
11—Ports of a Tractor Protection Valve ....... 25
12—Parts and Ports of a Trailer Air Supply Valve ....... 27

3. Answers to Assignment Sheets ....... 29

4. Written Test ....... 31

5. Answers to Written Test ....... 41

6. Unit Evaluation Form ....... 43

**Student Components** **Student Page**

DT:B

1. Objective Sheet ....... C-115

2. Information Sheet ....... C-117

3. Student Supplement

1—Truck/Tractor Troubleshooting Guide ....... C-133

## Unit Contents

4. Assignment Sheets

1—Identify and Connect Components in a Truck Brake System . . . . . . . . . . . . . . . . C-137
2—Identify and Connect Components in a Tractor Brake System . . . . . . . . . . . . . . . C-139

5. Job Sheets

1—Inspect and Test Parking Brake Hand (Control) Valve; Replace as Needed . . . . . C-141
2—Inspect and Test Inversion Valve; Replace as Needed . . . . . . . . . . . . . . . . . . . . . C-147
3—Inspect and Test Anti-Compounding Circuit Equipped with Quick Release-1C; Replace as Needed . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . C-151
4—Inspect and Test Trailer Air Supply Valve; Replace as Needed . . . . . . . . . . . . . . . C-155
5—Inspect and Test Trailer Brake Control Valve (Hand Valve); Replace as Needed . . C-161
6—Inspect and Test Tractor Protection Valve; Replace as Needed . . . . . . . . . . . . . . C-165
7—Check Operation of Parking Brake; Remove, Inspect, and Replace Parking Brake (Spring Brake) Chamber as Needed . . . . . . . . . . . . . . . . . . . . . . . . . . . . C-169

# Special Circuits
## Unit 4-C

### Suggested Activities

**Instructional Plan**

**Preparation**

1. Read the unit carefully and plan for instruction.
2. Review "Teaching Suggestions." Plan for classroom activities.
3. Plan for students with special needs.
4. Obtain videotapes, service manuals, and other resources to supplement instruction of this unit. See "Resources" for more information.
5. Make transparencies from the transparency masters included in this unit.
6. Develop teaching plan. Adjust for different learning styles.
7. Review "Instructions for Evaluating Student Performance."
8. Make copies of the Unit Evaluation Form, one for each student.

**Delivery and Application**

9. Provide students with unit of instruction.
10. Discuss unit and specific objectives.
11. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
12. Discuss the assignment sheets. Review criteria for the evaluation of these activities.
13. Discuss and demonstrate the job sheets. Make sure all required tools, equipment, and supplies are available. Review criteria for evaluation of these activities.

**Evaluation**

14. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.
15. Make copies of the written test. Add or modify test items as needed.
16. Give written test.
17. Compile assignment sheet ratings, job sheet ratings, and written test scores on the Unit Evaluation Form. Add any additional assignments or supplemental activities that should be part of the unit evaluation.
18. Reteach and retest as required.

## Suggested Activities

### Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A Report for America 2000* and *Workplace Basics: The Skills Employers Want.* These have been adapted by MAVCC.

1. Introduce the unit by using a toy truck to demonstrate how a truck will roll on a grade. Have the students think about the fact that air-powered brakes need pressurized air from a running engine. Ask how braking power can be provided if the engine is not running, such as when the truck is parked for a period of time on an incline. If the students suggest that the power can be provided by the reservoirs, point out to them what their leakage tests have shown in previous units and suggest that even a 2-3 psi per minute leak through the entire system would quickly deplete the air system. **(Thinking Skills—Reasoning; Systems—Interrelationships)**

2. Discuss compounding and why it is important to avoid. Display distorted foundation brake and air chamber components to discuss results of compounding. Point out that parking brake/emergency brake circuits provide anti-compounding subcircuits. **(Thinking Skills—Reasoning)**

3. Discuss the purpose of a parking brake system. Since many of the students will be familiar with the fact that most automobile drivers do not use their parking brakes, guide the discussion about why parking brakes are so important on large trucks. **(Thinking Skills—Reasoning)**

4. Discuss components related to the emergency circuit, such as low-pressure indicators and wig-wags. Display flow diagrams with low-pressure indicators and exhibit examples of such components. Allow the students to see driver notifications of low pressure. **(Thinking Skills—Reasoning; Systems—Interrelationships)**

5. Show examples of integrated brake components along with the separate components that are combined in the integrated unit. Particularly applicable to this unit are integrated air and spring brake chambers, integrated dash control valves, and integrated quick-release valves (relay valves and spring brake control valves). **(Thinking Skills—Reasoning)**

6. Display vehicles that use anti-compounding quick-release and relay valves and have the students analyze the piping of the circuits. **(Thinking Skills—Reasoning; Systems—Interrelationships)**

7. Discuss safety concerns with spring brake chambers and how each of the four conditions influence the dangers of the spring brake chambers. Demonstrate any safety tools used in your facility for service involving the spring brake chambers. **(Personal Management Skills—Responsibility and organizational effectiveness [value of safety])**

8. Review regulatory requirements related to the parking and emergency circuits and discuss how each component contributes to compliance with those requirements. **(Thinking Skills—Reasoning; Personal Management Skills—Responsibility)**

### Resources Used in Developing This Unit

1. *The Air Brake Book*, 5th revised ed. Radnor, PA: Commercial Carrier Journal.

2. *Air Brake Handbook.* Elyria, OH: AlliedSignal Automotive, Truck Brake Systems Company, 1995.

3. *Air Brake System.* Allentown, PA: Mack Trucks, 1986.

4. *Grey-Rock Heavy Duty Brake Service Manual.* Owosso, MI: Grey-Rock, 1983.

## Suggested Activities

5. Norman, Ian Andrew et al. *Heavy Duty Truck Systems*, 2nd ed. Albany, NY: Delmar Publishers, Inc. 1996.
6. *Stopping the Big Rigs: Training Manual for Air Brake Systems.* Kansas City, MO: Midland-Grau Heavy Duty Systems, 1995.
7. *Workbook and Learning Aid for Air Brake Systems.* Kansas City, MO: Midland-Grau Heavy Duty Systems, 1991.

### Suggested Supplemental Resource

1. Emergency and Park System, Part 3, BW1676, VHS training video.

   Available from:

   AlliedSignal Truck Brake Systems Co.
   901 Cleveland Street
   P.O. Box 4016
   Elyria, OH 44036-2016
   1-216-329-9000

### Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

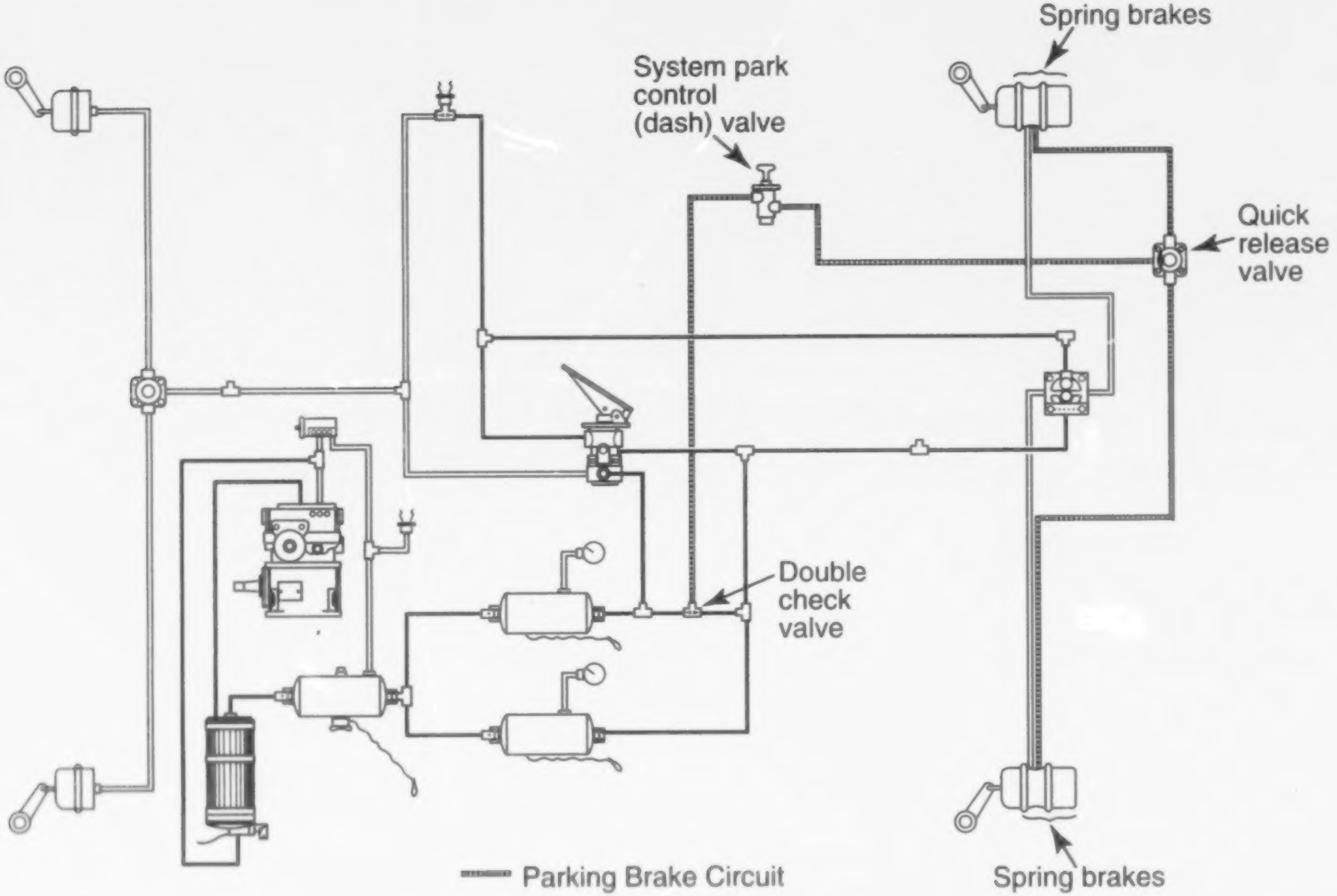
4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

Option B

Yes—Can perform job with no additional training.

No—Is unable to perform job satisfactorily.

# Components of the Parking Circuit



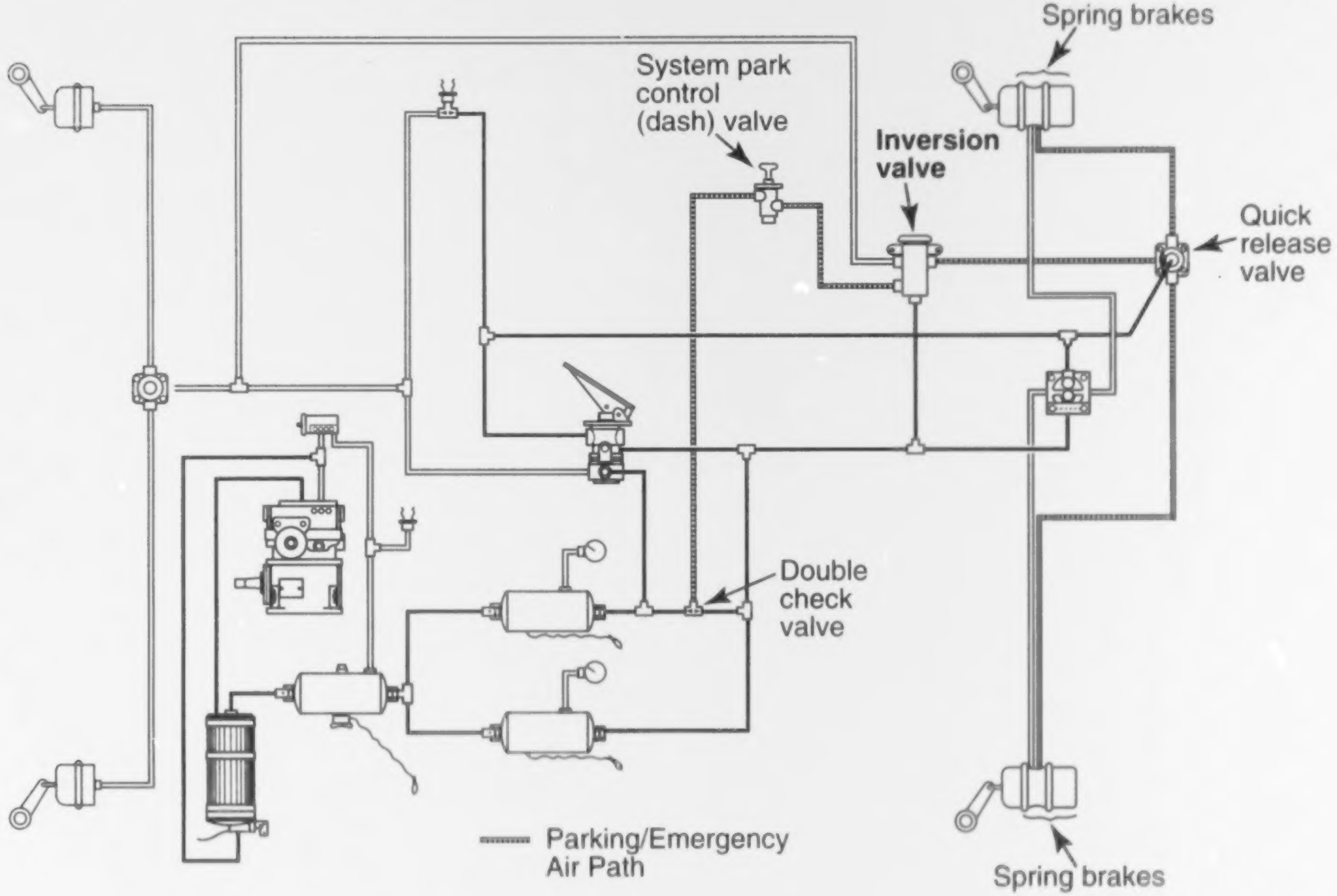
Spring brakes
System park control (dash) valve
Quick release valve
Double check valve
Parking Brake Circuit
Spring brakes

Courtesy of Haldex Midland Services

*Diesel Technology: Brakes,* Unit 4-C
Teacher Page 5

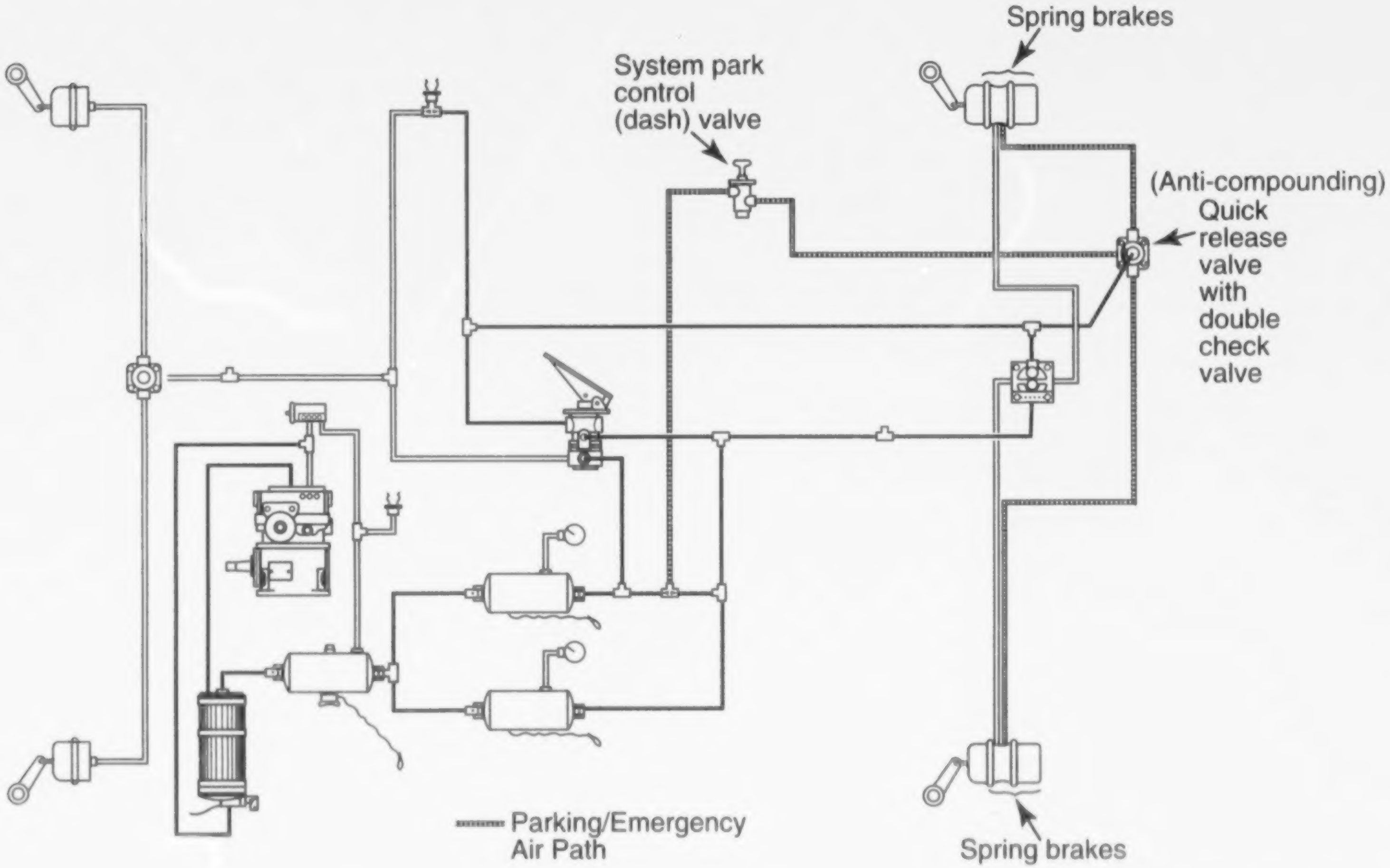
TM 1

# Components of the Emergency Circuit


Spring brakes
System park control (dash) valve
**Inversion valve**
Quick release valve
Double check valve
Parking/Emergency Air Path
Spring brakes

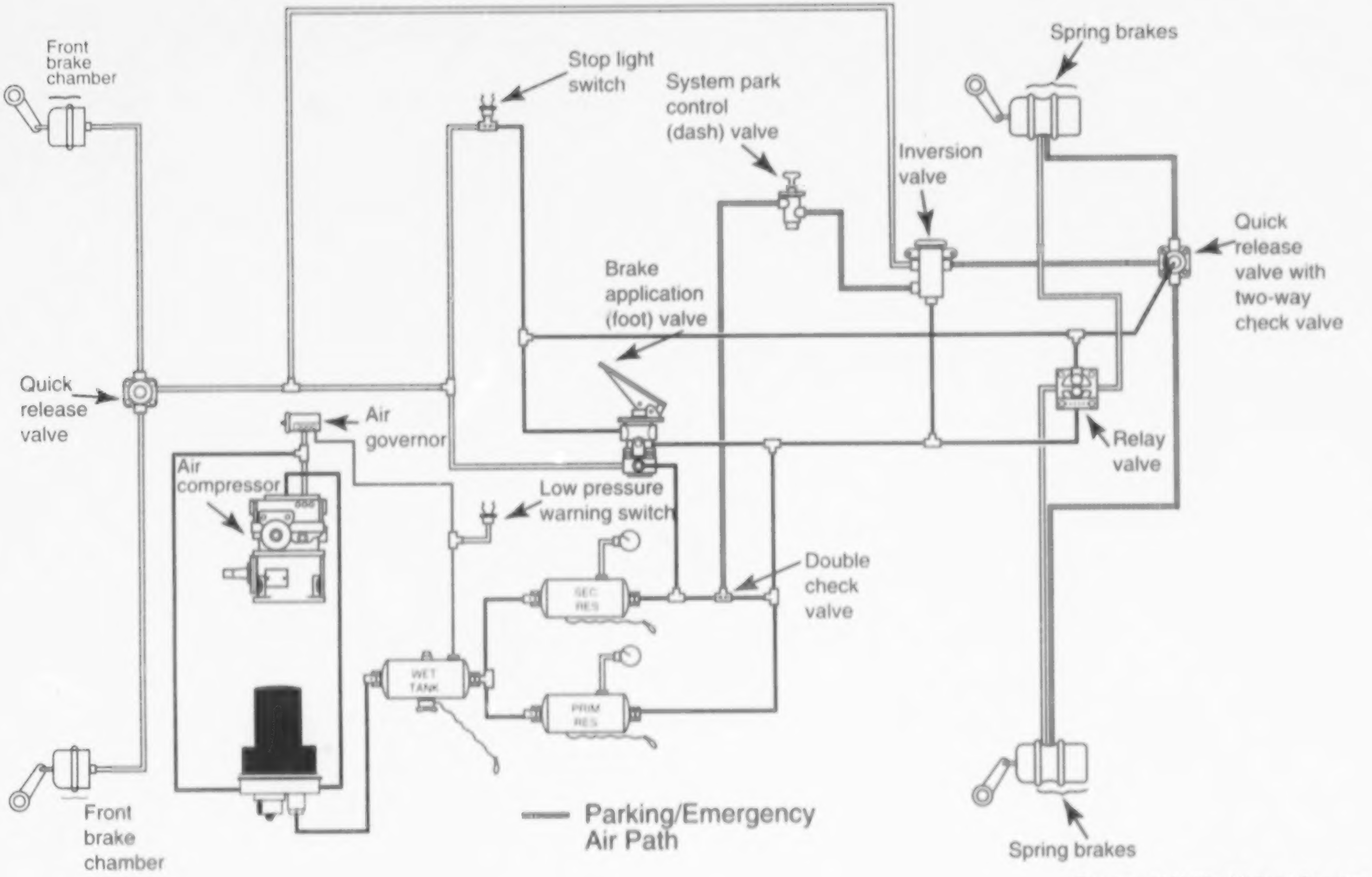
Courtesy of Haldex Midland Services

# Components of the Anti-Compounding Circuit


Spring brakes
System park control (dash) valve
(Anti-compounding) Quick release valve with double check valve
Spring brakes
▬ Parking/Emergency Air Path

Courtesy of Haldex Midland Services

# Typical Truck Brake System


Front brake chamber
Stop light switch
System park control (dash) valve
Spring brakes
Inversion valve
Quick release valve with two-way check valve
Brake application (foot) valve
Quick release valve
Air governor
Air compressor
Low pressure warning switch
Relay valve
SEC RES
Double check valve
WET TANK
PRIM RES
Front brake chamber
Spring brakes

— Parking/Emergency Air Path

Courtesy of Haldex Midland Services

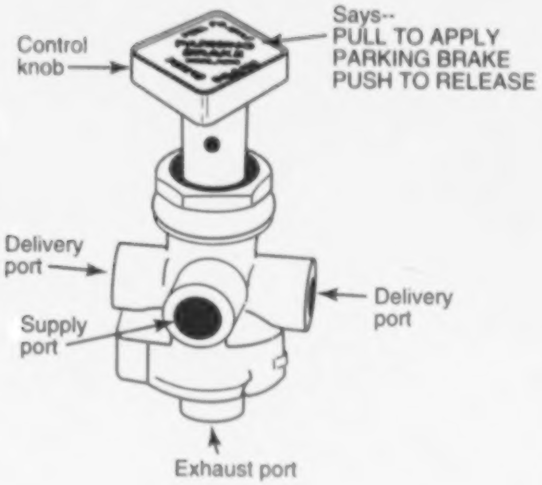
*Diesel Technology: Brakes,* Unit 4-C
Teacher Page 11

TM 4

271

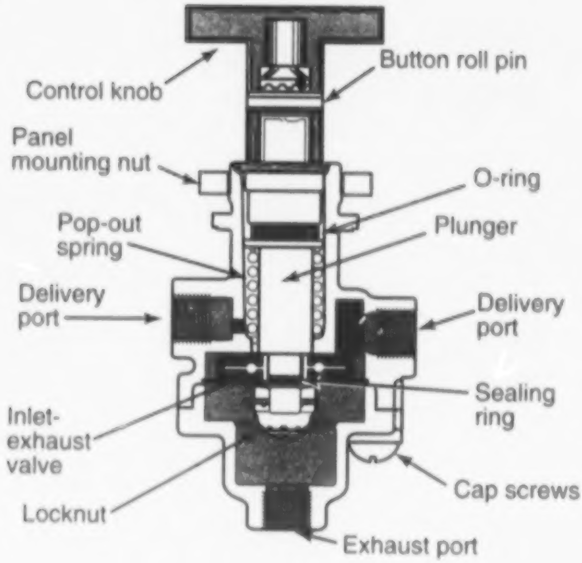
272

# Parts and Ports of a System Park Control Valve


Control knob
Says--
PULL TO APPLY
PARKING BRAKE
PUSH TO RELEASE
Delivery port
Delivery port
Supply port
Exhaust port

## Exterior View

Courtesy of Haldex Midland Services

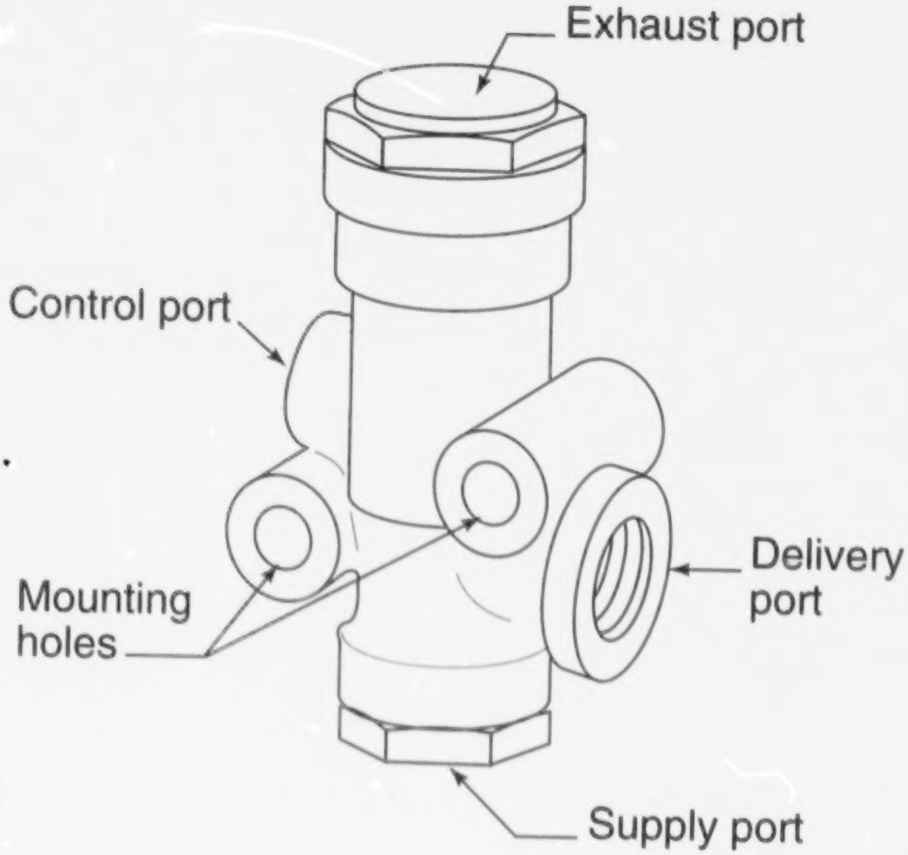

Control knob
Button roll pin
Panel mounting nut
O-ring
Pop-out spring
Plunger
Delivery port
Delivery port
Sealing ring
Inlet-exhaust valve
Cap screws
Locknut
Exhaust port

## Cross Section View

Courtesy of AlliedSignal Bendix

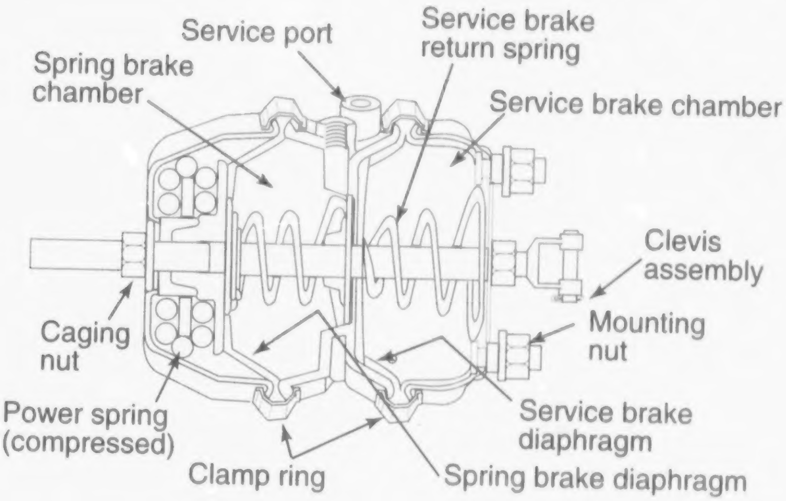
TM 5

# Ports of an Inversion Valve

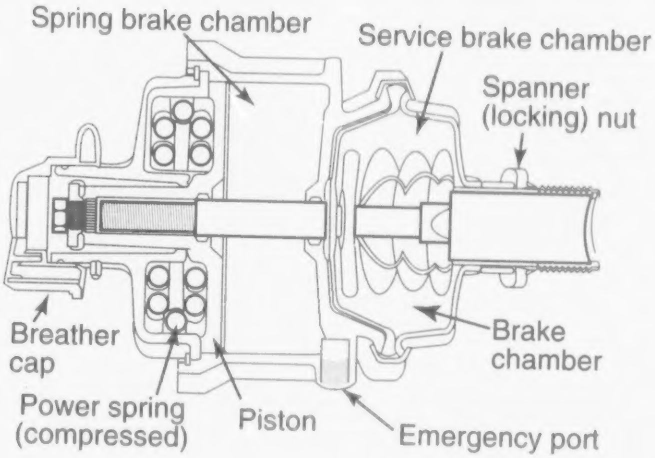

Exhaust port
Control port
Mounting holes
Delivery port
Supply port

Courtesy of AlliedSignal Bendix

# Parts and Ports of a Spring Brake (Rear Axles)


Service port
Spring brake chamber
Service brake return spring
Service brake chamber
Clevis assembly
Mounting nut
Caging nut
Power spring (compressed)
Service brake diaphragm
Clamp ring
Spring brake diaphragm

## Spring Brake for S-Cam-Type and Disc-Type Brakes


Spring brake chamber
Service brake chamber
Spanner (locking) nut
Breather cap
Brake chamber
Power spring (compressed)
Piston
Emergency port

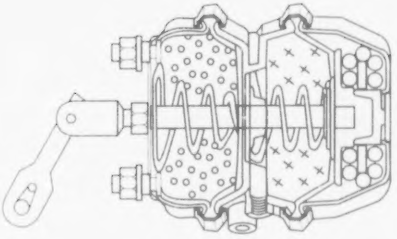
## Spring Brake for Wedge-Type Brakes

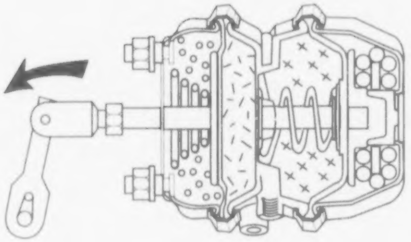
Courtesy of Haldex Midland Services

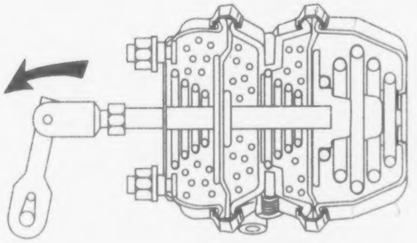
275

TM 7

# Operation of Spring Brakes







## Normal Driving

Air pressure within the system holds spring brakes released, but always ready for parking or emergency application.

## Normal Service Brake

Spring brake does not apply with normal service brake application as air pressure keeps the spring caged.

+ Spring brake hold off pressure

- Service air pressure

○ Atmosphere pressure

## Emergency Brakes

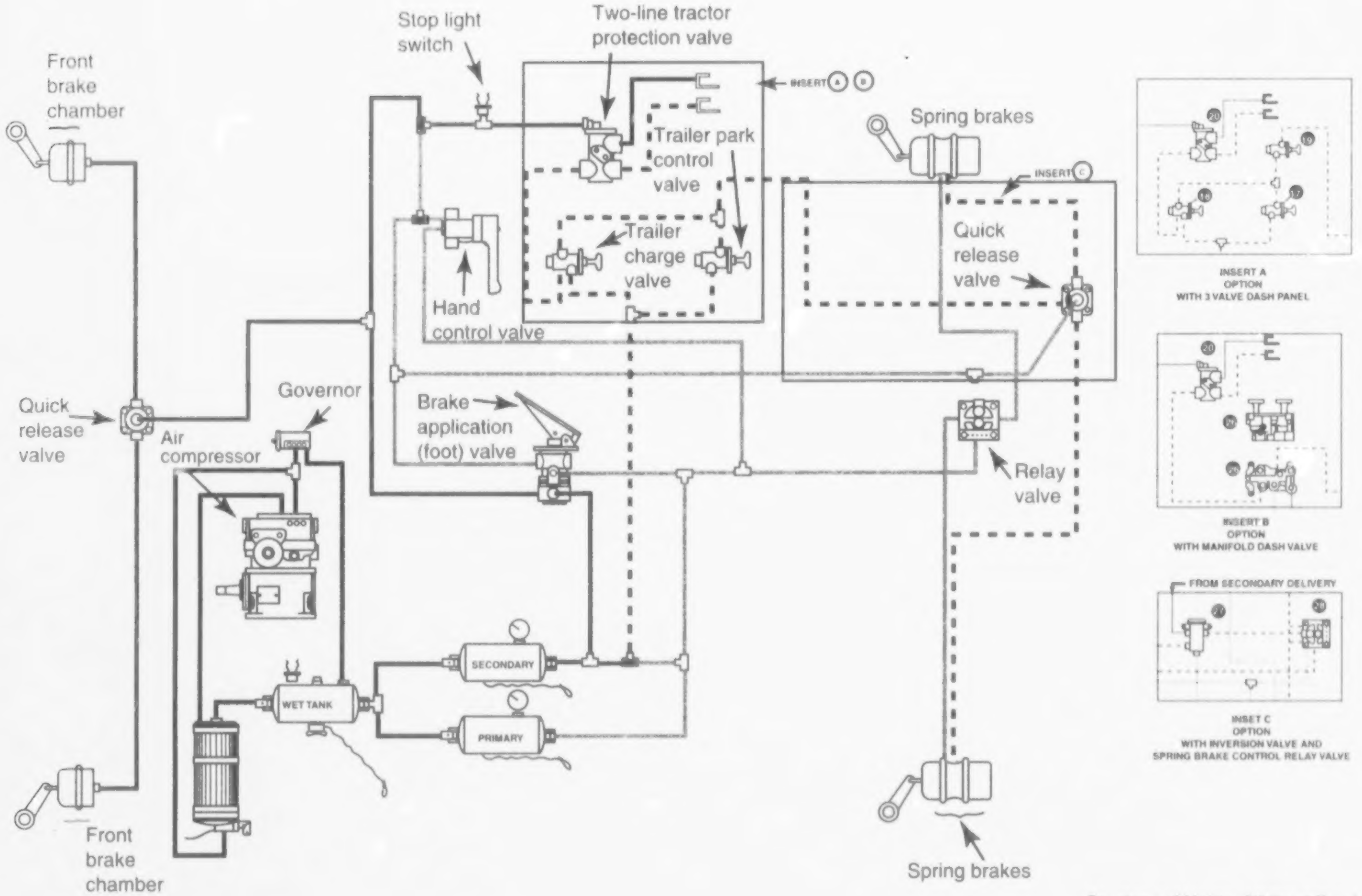
The spring brake is installed to operate either automatically upon total loss of air pressure or by foot valve modulated application when there is a loss of pressure in the primary air system.

## Parking Brakes

Application of the dash control valve exhausts air from the spring brake chamber, permitting the spring force to apply the service brake for positive parking.

Courtesy of Meritor Automotive, Inc.

# Typical Tractor Brake System

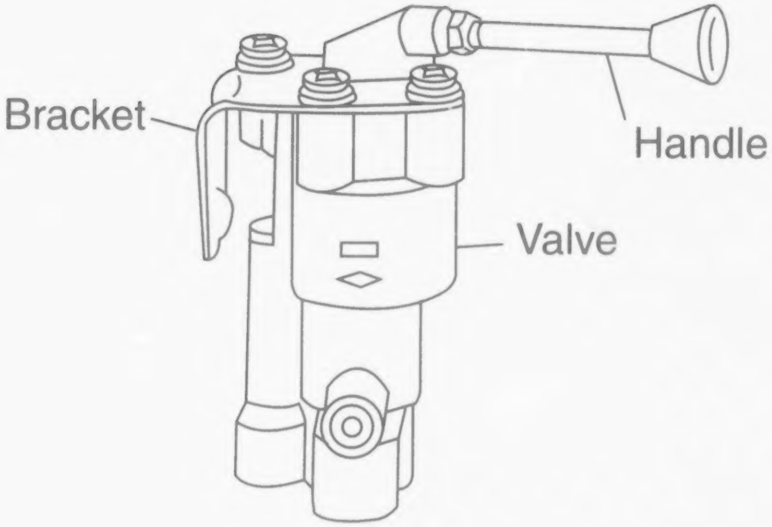

Stop light switch
Two-line tractor protection valve
INSERT A B
Front brake chamber
Trailer park control valve
Spring brakes
INSERT C
Trailer charge valve
Quick release valve
Hand control valve
Quick release valve
Governor
Brake application (foot) valve
Air compressor
Relay valve
SECONDARY
WET TANK
PRIMARY
Front brake chamber
Spring brakes
20
19
18
17
INSERT A
OPTION
WITH 3 VALVE DASH PANEL
20
INSERT B
OPTION
WITH MANIFOLD DASH VALVE
FROM SECONDARY DELIVERY
INSET C
OPTION
WITH INVERSION VALVE AND
SPRING BRAKE CONTROL RELAY VALVE

Courtesy of Haldex Midland Services

*Diesel Technology: Brakes,* Unit 4-C
Teacher Page 21

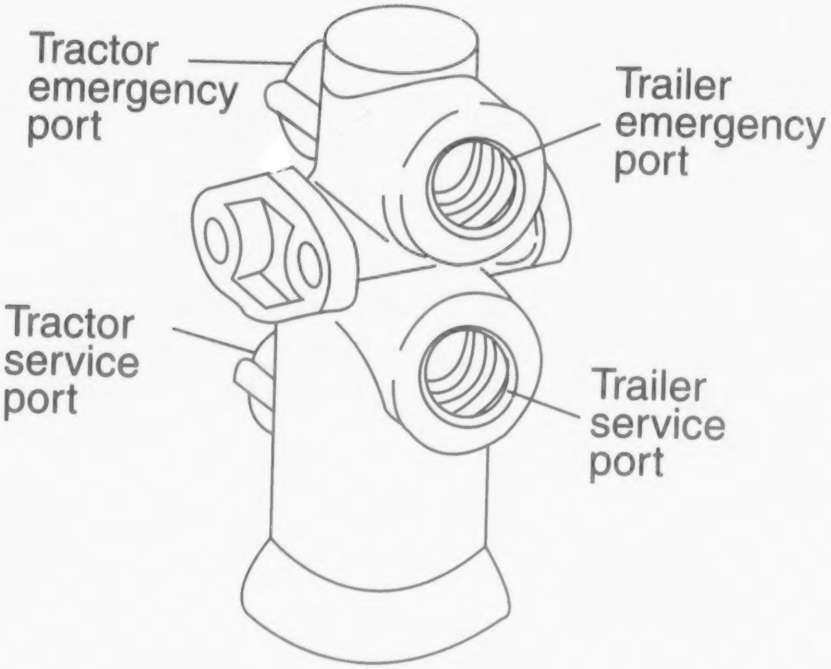
TM 9

# Parts of a Hand Control Valve


Bracket
Handle
Valve

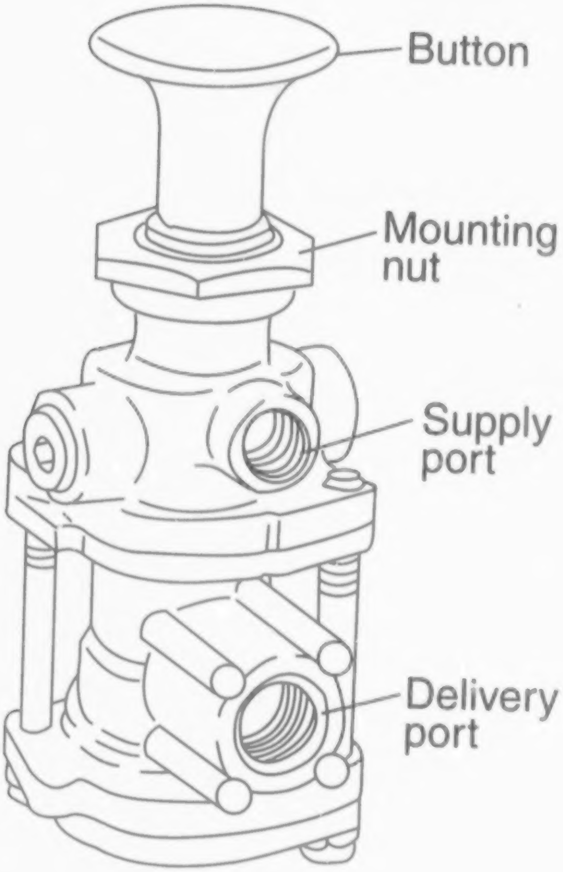
Courtesy of AlliedSignal Bendix

# Ports of a Tractor Protection Valve


Tractor emergency port
Trailer emergency port
Tractor service port
Trailer service port

Courtesy of AlliedSignal Bendix

# Parts and Ports of a Trailer Air Supply Valve

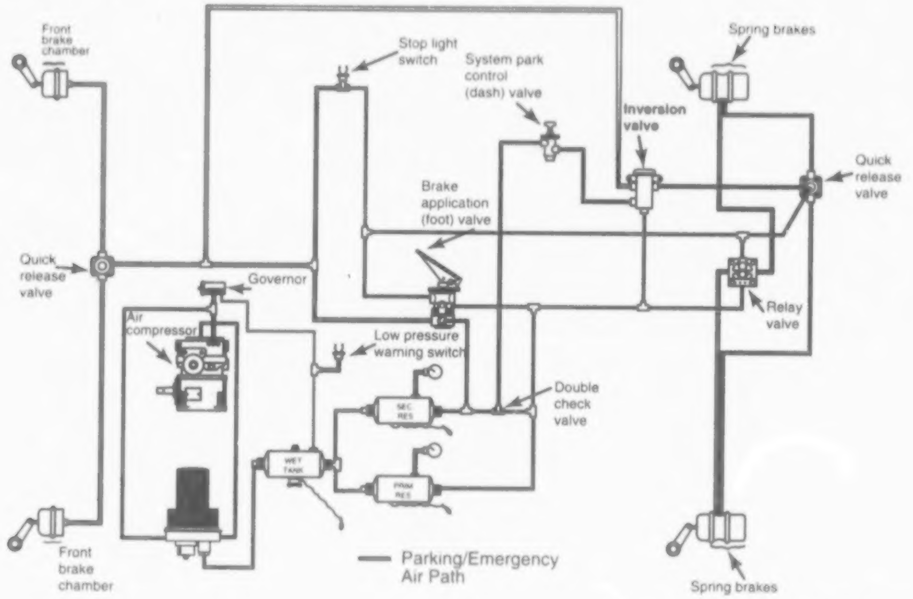

Button
Mounting nut
Supply port
Delivery port

Courtesy of AlliedSignal Bendix

# Special Circuits
## Unit 4-C

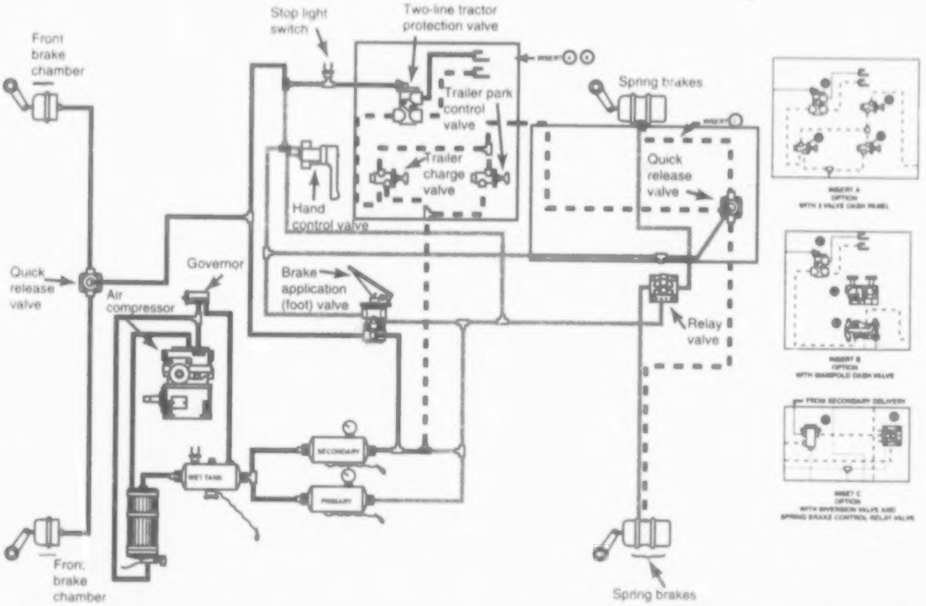
## Answers to Assignment Sheets

### Answers to Assignment Sheet 1


Front brake chamber
Stop light switch
System park control (dash) valve
Spring brakes
Inversion valve
Quick release valve
Brake application (foot) valve
Quick release valve
Governor
Relay valve
Air compressor
Low pressure warning switch
SEC RES
Double check valve
WET TANK
PRIM RES
Front brake chamber
Parking/Emergency Air Path
Spring brakes

Courtesy of Haldex Midland Services

### Answers to Assignment Sheet 2


Stop light switch
Two-line tractor protection valve
INSERT
Front brake chamber
Trailer park control valve
Spring brakes
INSERT
Trailer charge valve
Quick release valve
Hand control valve
Quick release valve
Governor
Brake application (foot) valve
Air compressor
Relay valve
SECONDARY
WET TANK
PRIMARY
Front brake chamber
Spring brakes
INSERT A
OPTION
WITH 3 VALVE DASH PANEL
INSERT B
OPTION
WITH MANIFOLD DASH VALVE
FROM SECONDARY DELIVERY
INSERT C
OPTION
WITH INVERSION VALVE AND
SPRING BRAKE CONTROL RELAY VALVE

Courtesy of Haldex Midland Services

BEST COPY AVAILABLE

# Special Circuits
# Unit 4-C

## Written Test

Name ______________________________ Date ____________ Score ____________

1. Match the terms on the right with the correct definitions.

______ a. Pressure within a circuit used to regulate the functioning of the system

______ b. Tandem-chamber brake actuator that incorporates an air-applied service brake chamber and an air-releasing/spring-applied parking or emergency brake chamber

______ c. Applies trailer brakes only; cannot be used for parking

______ d. Condition of being reversed from the normal position, order, or relationship

______ e. Combining forces; may cause damage if maximum force allowed is exceeded

______ f. Protects the tractor brake system pressure if the air supply system is shut off or if the pressure drops below the minimum 45psi

______ g. To confine

______ h. Provides driver control over the flow of air to the trailer

______ i. Special valve that is normally open instead of normally closed; operates by releasing pressure rather than by applying pressure

1. Cage
2. Compounding
3. Control pressure
4. Hand control valve
5. Inversion
6. Inversion valve
7. Spring brake
8. Tractor protection valve
9. Trailer air supply valve

2. Distinguish among the purposes of the special circuits for a truck brake system by placing a "P" next to the purpose of a parking circuit, an "E" next to the purpose of an emergency circuit, and an "A" next to the purpose of an anti-compounding circuit.

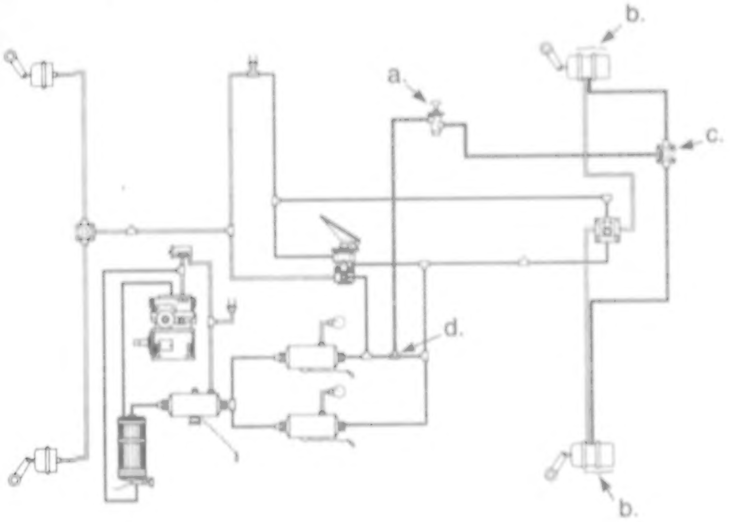
______ a. To apply the brakes in the event of a loss of air pressure in both service brake circuits and/or emergency circuit

______ b. To control the application and release of the spring brake in order to hold the vehicle stationary when stopped

______ c. To prevent the application of the spring brake while the service brake is being applied, thereby preventing damage to the foundation brake components

## Written Test

3. Identify the components of the parking circuit. Write your answers in the blanks below.

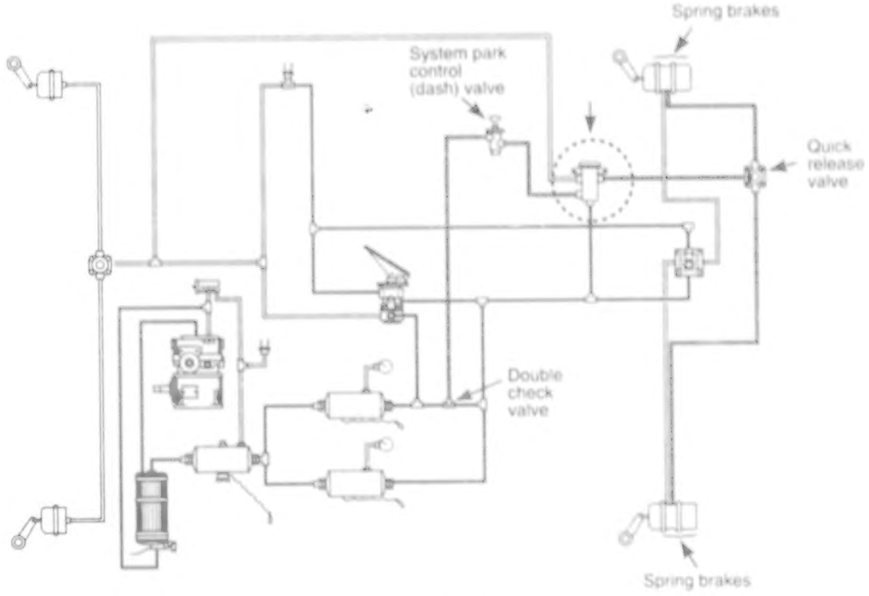


a. ______________________ b. ______________________

c. ______________________ d. ______________________

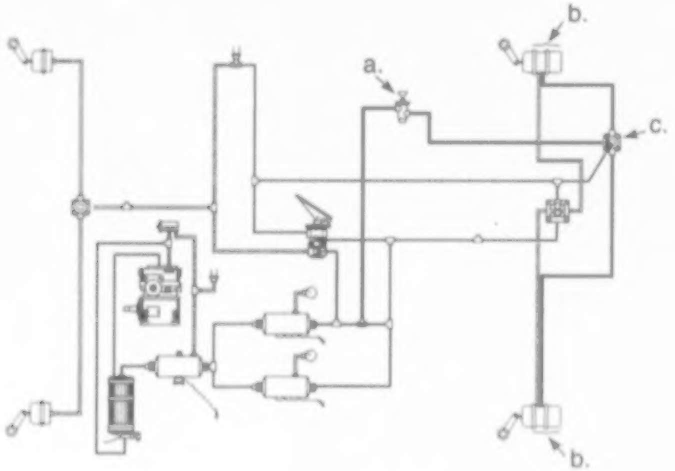
4. Identify the component that is unique to the emergency circuit. Write your answer in the blank below.

______________________


Spring brakes
System park control (dash) valve
Quick release valve
Double check valve
Spring brakes

## Written Test

5. Identify the components of the anti-compounding circuit. Write your answers in the blanks below.



a. ______________________ b. ______________________

c. ______________________

6. Describe the two conditions in which compounding can occur.

a. ______________________

b. ______________________

## Written Test

7. Match special circuit components of the truck brake system on the right with their functions.

_______ a. Have two chambers that perform different functions: one is used for standard service braking and the other is used to apply service brakes in case of air loss that can happen in parking or emergency situations

_______ b. Special valve that only operates in the event of a primary service reservoir failure (rear service brakes)

_______ c. Senses available air pressure from the primary and secondary service circuits and allows air to be delivered to the parking circuit from the circuit with the higher pressure

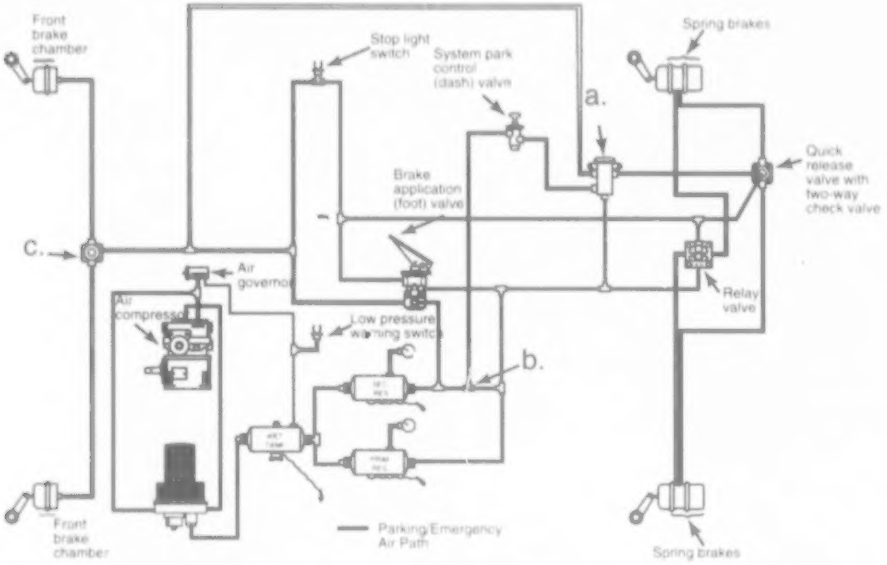
_______ d. Allows driver to apply and release the spring parking and/or emergency brakes

_______ e. Releases air from the spring brake chambers to allow application of the spring brakes

_______ f. Acts as an anti-compounding device to balance service brake line pressure with spring brake line pressure

1. Double (two-way) check valve
2. System park control (dash) valve
3. Quick release valve
4. Quick release valve with double check valve
5. Spring brakes
6. Inversion valve

8. Identify special circuit components of the truck brake system. Write your answers in the blanks below.

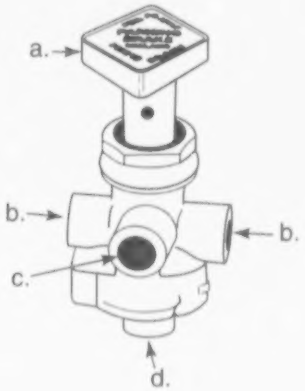

Front brake chamber
Stop light switch
System park control (dash) valve
a.
Spring brakes
Quick release valve with two-way check valve
Brake application (foot) valve
C.
Air governor
Air compressor
Low pressure warning switch
Relay valve
b.
Parking/Emergency Air Path
Front brake chamber
Spring brakes

a. ______________________ b. ______________________

c. ______________________

## Written Test

9. Identify the parts and ports of a system park control valve. Write your answers in the blanks below.



a. ______________________ b. ______________________

c. ______________________ d. ______________________

10. Complete the following statements concerning the characteristics of the system park control valve by filling in the blanks with the correct answers.

The system park control valve . . .

a. Is used on ________________ models with air brakes

b. Has a ________________ diamond-shaped control knob

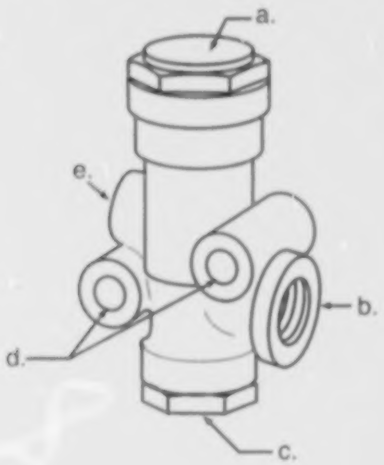
c. Is mounted on the cab's ________________ ________________

d. Applies vehicle spring brakes when knob is ________________ ________________

e. Can serve as an ________________ brake control

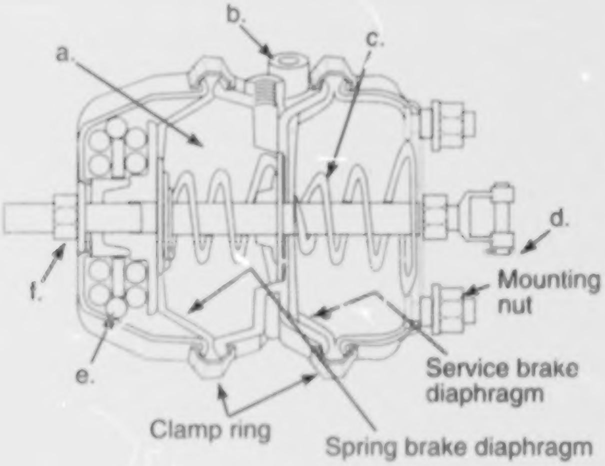
## Written Test

11. Identify the ports of an inversion valve. Write your answers in the blanks below.



a.
b.
c.
d.
e.

12. Identify the parts and port of a spring brake. Write your answers in the blanks below.


b.
a.
c.
d.
Mounting nut
f.
e.
Service brake diaphragm
Clamp ring
Spring brake diaphragm

a.
b.
c.
d.
e.
f.

## Written Test

13. Complete statements concerning the operation of spring brakes by filling in the blanks with the correct answers.

    a. Spring brakes are designed to automatically apply the vehicle's service brakes in case of ____________ ____________.

    b. Spring brakes remain applied until that chamber is recharged with air or the spring is ____________ compressed or caged.

    c. Spring brakes may be either ____________ type or ____________ type, but both rely on air pressure to keep the brake in the compressed position until they are applied manually or automatically.

    d. The spring portion often is referred to as the ____________ ____________.

    e. During normal driving, air pressure within the system holds the spring brakes ____________ by keeping the heavy duty spring brake compressed.

    f. The compressed ____________ ____________ in a spring brake is very powerful and very dangerous. It is important that you follow all safety precautions when servicing spring brakes.

    g. Always use the manual release to ____________ the spring brake prior to service to prevent unwanted application.

14. Select true statements concerning regulatory requirements of parking and emergency circuits by placing an "X" next to the true statements.

    ______ a. Must be capable of holding the fully loaded vehicle stationary while it is parked on a 45% grade

    ______ b. Must apply automatically if reservoir pressure drops below a specific level

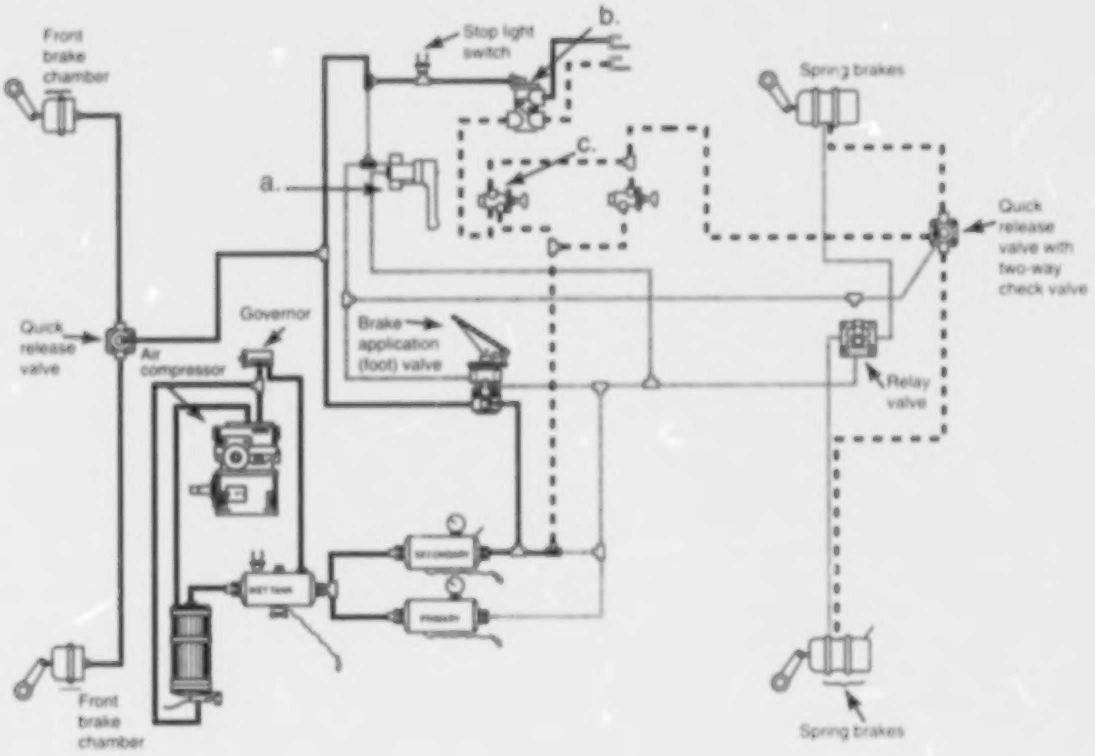
    ______ c. Must be effective despite a failure in other brake circuits, including service brakes

    ______ d. Must have joint controls

    ______ e. Must be able to release at least once after automatic application

    ______ f. Must achieve required park within 6 seconds

15. Identify components of the tractor brake system. Write your answers in the blanks below.


Front brake chamber
Stop light switch
b.
Spring brakes
c.
a.
Quick release valve with two-way check valve
Quick release valve
Governor
Air compressor
Brake application (foot) valve
Relay valve
Front brake chamber
Spring brakes

a. ______________________ b. ______________________

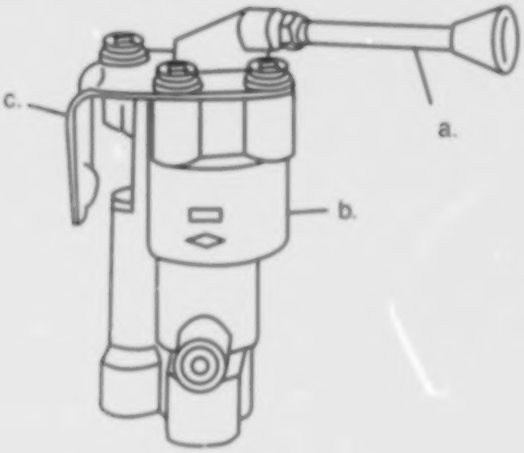
c. ______________________

16. Match truck/tractor circuit components on the right with their functions.

| | | |
|---|---|---|
| _______ a. Supplies pressurized air to the trailer brake system | | 1. Hand control valve |
| _______ b. Controls the trailer only | | 2. Tractor protection valve |
| _______ c. Protects the tractor's air system in the event of a failure in the trailer or a trailer break-away | | 3. Trailer air supply valve |

291

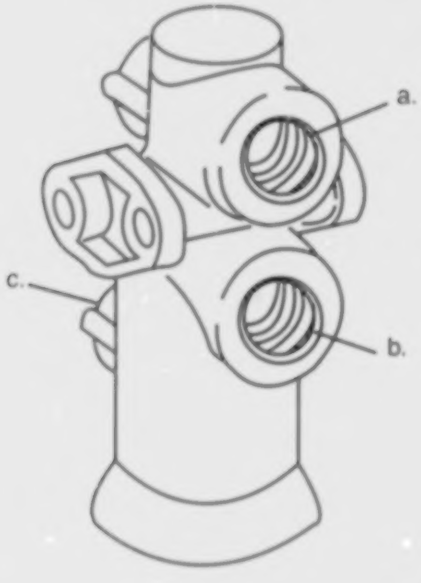
17. Identify parts of a hand control valve. Write your answers in the blanks below.



a. ______________________ b. ______________________

c. ______________________

18. Identify ports of a tractor protection valve. Write your answers in the blanks below.

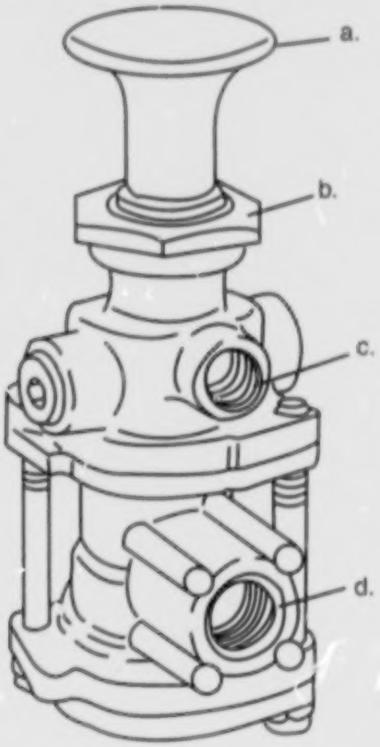


a. ______________________ b. ______________________

c. ______________________

## Written Test

19. Identify parts and ports of a trailer air supply valve. Write your answers in the blanks below.



a. ______________________ b. ______________________

c. ______________________ d. ______________________

Permission to duplicate this test is granted.

# Special Circuits
## Unit 4-C

### Answers to Written Test

1. a. 3
   b. 7
   c. 4
   d. 5
   e. 2
   f. 8
   g. 1
   h. 9
   i. 6

2. a. E
   b. P
   c. A

3. a. System park control (dash) valve
   b. Spring brakes
   c. Quick release valve
   d. Double check valve

4. Inversion valve

5. a System park control (dash) valve
   b. Spring brakes
   c. (Anti-compounding) quick release valve with double check valve

6. a. Parking brake is applied while driver has service brakes applied
   b. Service brake application during a low pressure situation

7. a. 5
   b. 6
   c. 1
   d. 2
   e. 3
   f. 4

8. a. Inversion valve
   b. Double check valve
   c. Quick release valve

9. a. Control knob
   b. Delivery port
   c. Supply port
   d. Exhaust port

10. a. all
    b. yellow
    c. instrument panel (dash)
    d. pulled out
    e. emergency

11. a. Exhaust port
    b. Delivery port
    c. Supply port
    d. Mounting holes
    e. Control port

## Answers to Written Test

12. a. Spring brake chamber
    b. Service port
    c. Service brake return spring
    d. Clevis assembly
    e. Power spring (compressed)
    f. Caging nut

13. a. air loss
    b. manually
    c. diaphragm, piston
    d. piggy back
    e. released
    f. power spring
    g. cage

14. b, c, e

15. a. Hand control valve
    b. Tractor protection valve
    c. Trailer air supply valve

16. a. 3
    b. 1
    c. 2

17. a. Handle
    b. Valve
    c. Bracket

18. a. Trailer emergency port
    b. Trailer service port
    c. Tractor service port

19. a. Button
    b. Mounting nut
    c. Supply port
    d. Delivery port

# Special Circuits
## Unit 4-C

### Unit Evaluation Form

Student Name ______________________________ Unit Rating ____________

Assignment Sheet 1—Identify and Connect Components in a Truck Brake System Rating ______

Comments: ______________________________________________

______________________________________________

Assignment Sheet 2—Identify and Connect Components in a Tractor Brake System Rating ______

Comments: ______________________________________________

______________________________________________

Job Sheet 1—Inspect and Test Parking Brake Hand (Control) Valve; Replace as Needed Rating ______

Comments: ______________________________________________

______________________________________________

Job Sheet 2—Inspect and Test Inversion Valve; Replace as Needed Rating ______

Comments: ______________________________________________

______________________________________________

Job Sheet 3—Inspect and Test Anti-Compounding Circuit Equipped with Quick Release (QR) 1-C; Replace as Needed Rating ______

Comments: ______________________________________________

______________________________________________

Job Sheet 4—Inspect and Test Trailer Air Supply Valve; Replace as Needed Rating ______

Comments: ______________________________________________

______________________________________________

Job Sheet 5—Inspect and Test Trailer Brake Control Valve (Hand Valve); Replace as Needed Rating ______

Comments: ______________________________________________

______________________________________________

## Unit Evaluation Form

Job Sheet 6—Inspect and Test Tractor Protection Valve; Replace as Needed Rating ______

Comments: ______________________________

______________________________

Job Sheet 7—Check Operation of Parking Brake; Remove, Inspect, and Replace Parking Brake (Spring Brake) Chamber as Needed Rating ______

Comments: ______________________________

______________________________

**Written Test Scores**

Pretest ________ Posttest ________ Other ________

Other ______________________________

______________________________

**Teacher Signature** ______________________ Date ______________

**Student Signature** ______________________ Date ______________

Permission to duplicate this form is granted.

# Trailer Air Brake Systems
# Unit 5-C

## Unit Contents

**Teacher Components** **Teacher Page**

1. Suggested Activities
    a. Instructional Plan .......... 1
    b. Teaching Suggestions .......... 2
    c. Resources Used in Developing This Unit .......... 2
    d. Instructions for Evaluating Student Performance .......... 3
2. Transparency Masters
    1—Trailer Air Brake System (Multi-Function) .......... 5
    2—Dollie System .......... 7
    3—Trailer Full Function Valve System .......... 9
    4—Ports of a Full Function Valve .......... 11
3. Answers to Assignment Sheet 1 .......... 13
4. Written Test .......... 15
5. Answers to Written Test .......... 19
6. Unit Evaluation Form .......... 21

**Student Components** **Student Page**

DT:B

1. Objective Sheet .......... C-175
2. Information Sheet .......... C-177
3. Student Supplement
    1—Trailer Systems Troubleshooting Guide .......... C-181
4. Assignment Sheet
    1—Identify and Connect Components of a Trailer Full Function Air Brake System .......... C-185
5. Job Sheets
    1—Inspect and Test Tractor Trailer Gladhands; Repair or Replace as Needed .......... C-187
    2—Inspect and Test Trailer Brake Full Function Valve; Replace as Needed .......... C-191

# Trailer Air Brake Systems
## Unit 5-C

### Suggested Activities

**Instructional Plan**

**Preparation**

1. Read the unit carefully and plan for instruction.
2. Review "Teaching Suggestions." Plan for classroom activities.
3. Plan for students with special needs.
4. Obtain videotapes, service manuals, and other resources to supplement instruction of this unit. See "Resources" for more information.
5. Make transparencies from the transparency masters included in this unit.
6. Develop teaching plan. Adjust for different learning styles.
7. Review "Instructions for Evaluating Student Performance."
8. Make copies of the Unit Evaluation Form, one for each student.

**Delivery and Application**

9. Provide students with unit of instruction.
10. Discuss unit and specific objectives.
11. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
12. Discuss the assignment sheet. Review criteria for the evaluation of this activity.
13. Discuss and demonstrate the job sheets. Make sure all required tools, equipment, and supplies are available. Review criteria for evaluation of these activities.

**Evaluation**

14. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.
15. Make copies of the written test. Add or modify test items as needed.
16. Give written test.
17. Compile assignment sheet rating, job sheet ratings, and written test scores on the Unit Evaluation Form. Add any additional assignments or supplemental activities that should be part of the unit evaluation.
18. Reteach and retest as required.

## Suggested Activities

### Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A Report for America 2000* and *Workplace Basics: The Skills Employers Want.* These have been adapted by MAVCC.

1. Provide students with an overview of the many types of trailers used today. Use Transparency 1 to show students a trailer brake system. Point out that the trailer brake system is very similar to that of the tractor, indicating that most trailers are dependent on the tractors that pull them for their air supply. **(Thinking Skills—Reasoning; Systems—Interrelationships)**
2. Discuss the design and operation of the trailer supply circuit, and explain how those components fit together, pointing out the type of hardware used to hold components in place. **(Thinking Skills—Reasoning; Systems—Interrelationships)**
3. Once the students understand the general functions of the trailer brake system, show them variations in circuit design, including various combinations of trailer supply and parking valves, different types of malfunction valves, etc. **(Thinking Skills—Reasoning; Information—Acquisition)**
4. Show examples of the various types of gladhands and seals and discuss the use of aluminum and cast iron and other considerations in the design and operation of gladhand seals. **(Thinking Skills—Reasoning)**
5. Demonstrate the care and service of gladhand seals. Allow students to connect and disconnect gladhands. **(Thinking Skills—Reasoning; Systems—Interrelationships)**
6. Discuss the importance of compatibility between tractor and trailer brake systems. Discuss concepts such as brake balance. **(Thinking Skills—Reasoning; Systems—Interrelationships)**
7. Discuss the function of full function valves and their role in the trailer brake system. **(Thinking Skills—Reasoning)**
8. Ask students to speculate on the kinds of problems that are likely to be encountered when operating and maintaining a braking system. For example, a wide variety of trailer designs that must be hooked up to tractors that will provide supply air, that must allow for convenient mating and unmating, and that will be driven over various terrains under varying weather conditions. Lead the discussion with questions. Examples: What if the trailer becomes disconnected? What if the tractors' air system fails? What if the driver wants to apply the trailer brakes without applying the tractor brakes? And, how can the trailer have parking brakes without the tractor being connected? **(Thinking Skills—Problem solving; Technology—Maintenance and troubleshooting)**

### Resources Used in Developing This Unit

1. *The Air Brake Book*, 5th revised ed. Radnor, PA: Commercial Carrier Journal.
2. *Air Brake Handbook*. Elyria, OH: AlliedSignal Automotive, Truck Brake Systems Company, 1995.
3. *Grey-Rock Heavy Duty Brake Service Manual*. Owosso, MI: Grey-Rock, 1983.
4. Norman, Ian Andrew et al. *Heavy Duty Truck Systems*, 2nd ed. Albany, NY: Delmar Publishers, Inc. 1996.

## Suggested Activities

5. Schulz, Erich J. *Diesel Equipment I: Lubrication, Hydraulics, Brakes, Wheels, and Tires.* Lake Forest, IL: Glencoe Division of Macmillian/McGraw-Hill Publishing Company, 1991.
6. *Task Team Training Manual for Air Brake Systems*, L20225. Kansas City, MO: Midland-Grau Heavy Duty Systems, 1993.
7. *Trailer Product Training*, L20023. Kansas City, MO: Midland-Grau Heavy Duty Systems, 1993.
8. *Workbook and Learning Aid for Air Brake Systems.* Kansas City, MO: Midland-Grau Heavy Duty Systems, 1991.

### Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

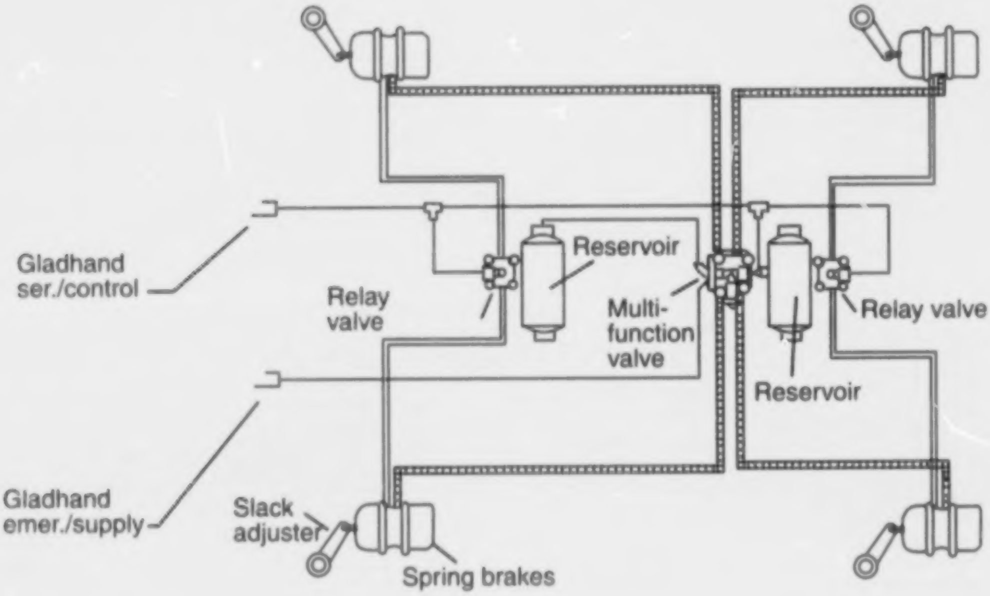
4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

Option B

Yes—Can perform job with no additional training.

No—Is unable to perform job satisfactorily.

# Trailer Air Brake System (Multi-Function)

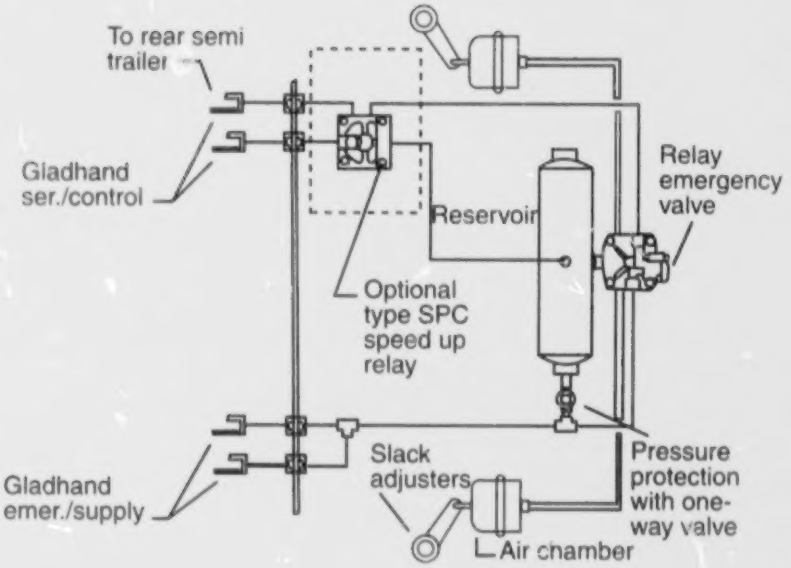

Reservoir
Gladhand
ser./control
Relay
valve
Multi-
function
valve
Relay valve
Reservoir
Gladhand
emer./supply
Slack
adjuster
Spring brakes

Courtesy of Haldex Midland Services

302

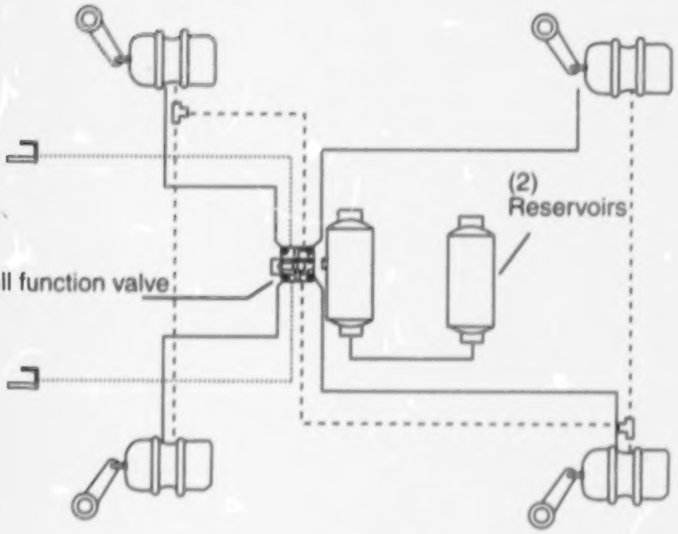
TM 1

# Dollie System

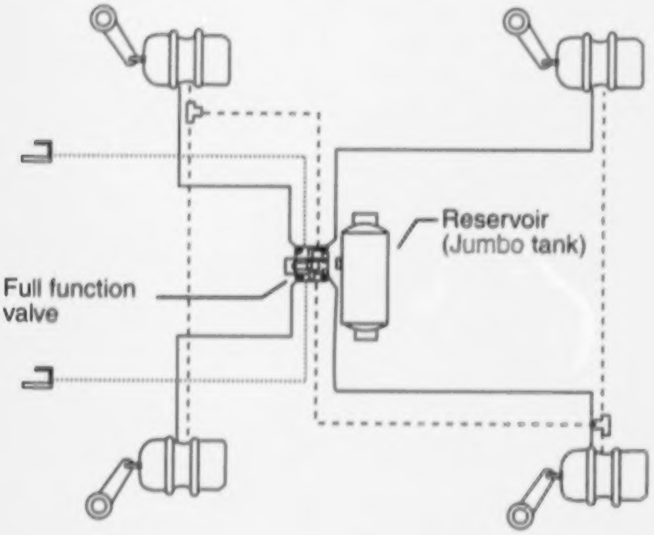

To rear semi trailer
Gladhand ser./control
Reservoir
Relay emergency valve
Optional type SPC speed up relay
Gladhand emer./supply
Slack adjusters
Pressure protection with one-way valve
Air chamber

Courtesy of AlliedSignal Bendix

# Trailer Full Function Valve System


(2)
Reservoirs
Full function valve

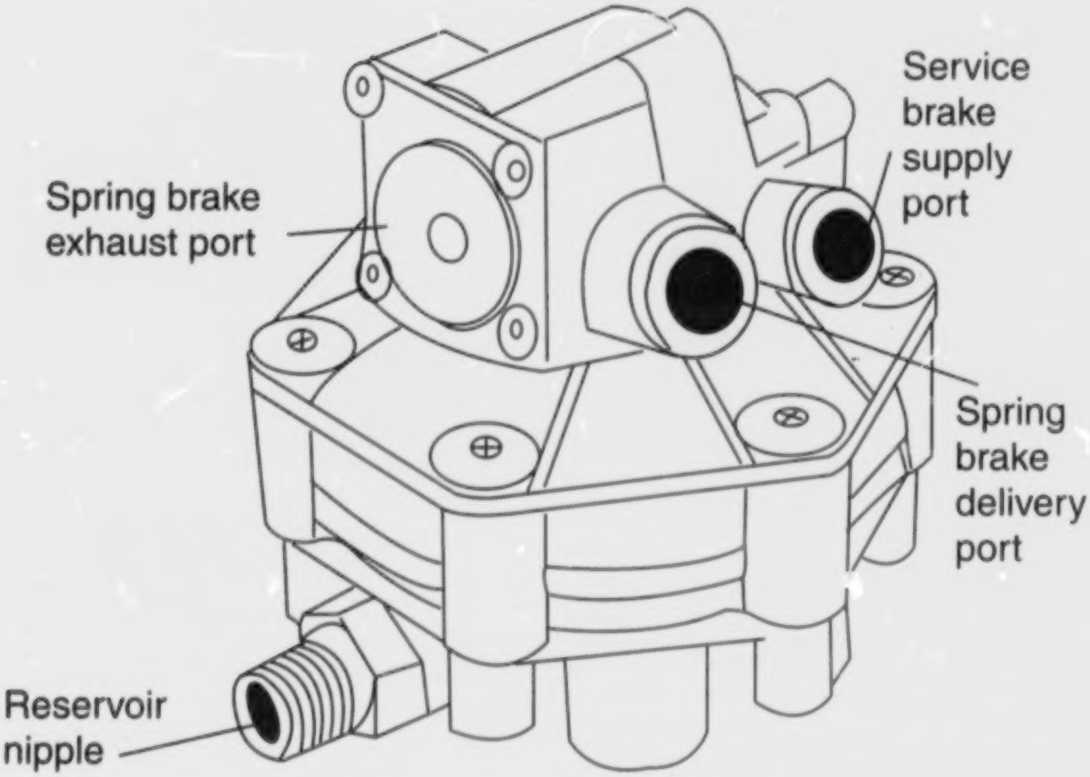
Two-Tank


Reservoir
(Jumbo tank)
Full function
valve

Single Jumbo Tank

Courtesy of Haldex Midland Services

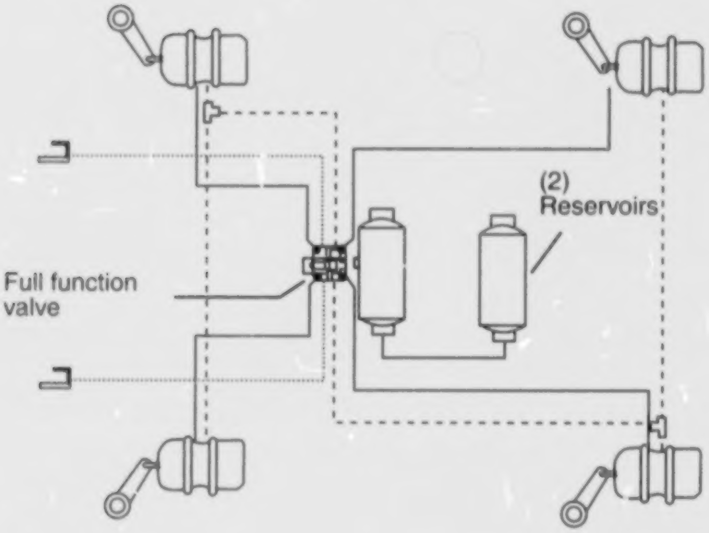
# Ports of a Full Function Valve


Service brake supply port
Spring brake exhaust port
Spring brake delivery port
Reservoir nipple

Courtesy of AlliedSignal Bendix

# Trailer Air Brake Systems
## Unit 5-C

### Answers to Assignment Sheet 1


(2)
Reservoirs
Full function
valve

Courtesy of Haldex Midland Services

# Trailer Air Brake Systems
# Unit 5-C

## Written Test

Name ______________________ Date ____________ Score ____________

1. Match the terms on the right with the correct definitions.

_______ a. To turn and rise to form an angle of 90° or less with each other

_______ b. Provides driver control over the flow of air to the trailer

_______ c. Special connector between tractor and trailer air lines that provides a good seal while allowing ease of connection and disconnection

_______ d. Provides regulated pressure to the trailer brake relay valve to provide proportional braking between the tractor and trailer

_______ e. An axle, frame, drawbar, and fifth wheel arrangement that converts a semitrailer into a full trailer

_______ f. Provides control over spring brakes and service brake

_______ g. Provides air pressure to charge the trailer reservoir from the tractor primary service reservoir

_______ h. Holds pressurized air supplied from the tractor

_______ i. Provides control over spring brakes (apply and release)

1. Converter dollie
2. Full function valve
3. Gladhand
4. Jackknife
5. Jumbo reservoir
6. Multi-function valve
7. Trailer emergency (supply) line
8. Trailer service line
9. Trailer air supply valve

2. Describe the two types of gladhands.

a. Emergency—______________________________________________

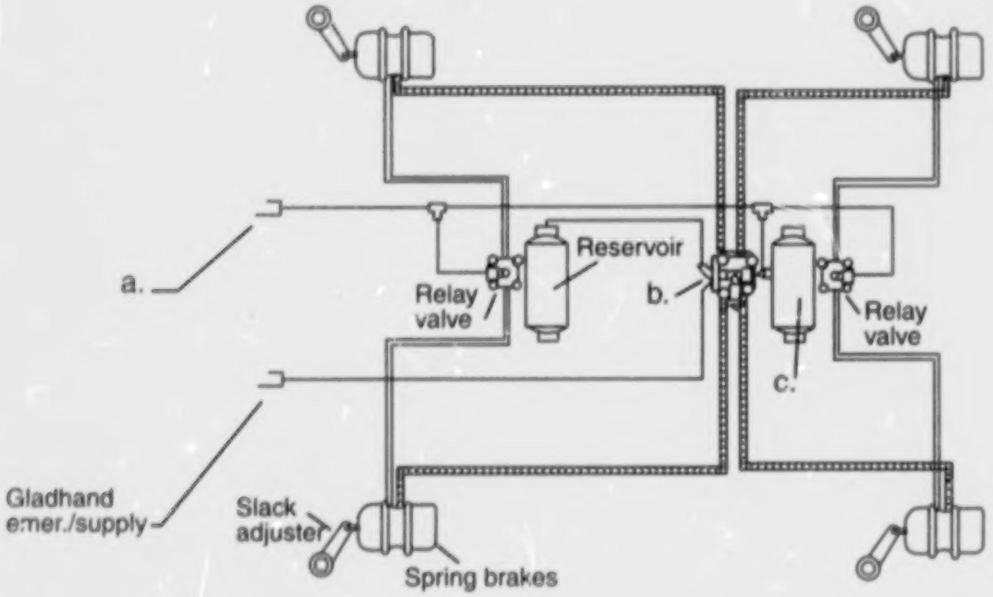
______________________________________________

b. Service—______________________________________________

______________________________________________

## Written Test

3. Identify components of the trailer air brake system. Write your answers in the blanks below.


Reservoir
a.
Relay valve
b.
Relay valve
c.
Gladhand emer./supply
Slack adjuster
Spring brakes

a. ______________________ b. ______________________

c. ______________________

4. Match components of the trailer air brake system on the right with their functions.

_______ a. House service brake chamber and park and emergency brake unit

_______ b. Provides a means of adjusting clearance between brake shoe and drum to compensate for lining wear

_______ c. Controls the spring brake

_______ d. Store the air reserve for service brakes

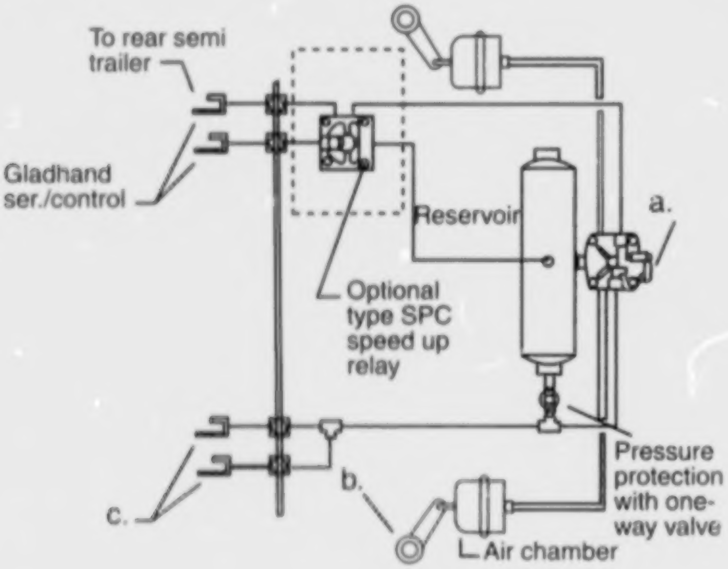
_______ e. Allow for quick connection/disconnection between the tractor's air lines and the trailer's air lines

_______ f. Provides air supply and releases air from service brakes

1. Multi-function valve
2. Relay valve
3. Gladhands
4. Reservoirs
5. Spring brakes
6. Slack adjuster

## Written Test

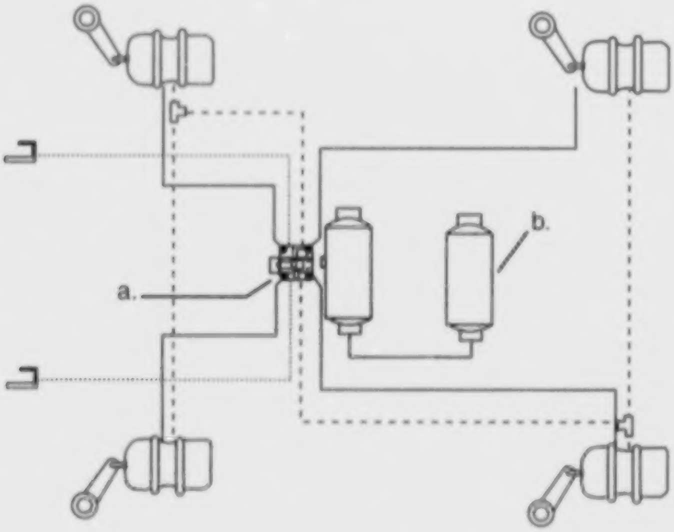
5. Identify components of the dollie system. Write your answers in the blanks below.


To rear semi trailer
Gladhand ser./control
Reservoir
a.
Optional type SPC speed up relay
Pressure protection with one-way valve
b.
c.
Air chamber

a. ______________________ b. ______________________

c. ______________________

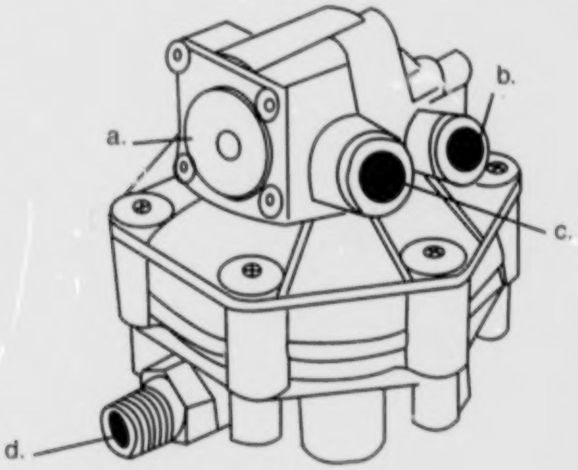
6. Identify components of the trailer full function valve system. Write your answers in the blanks below.



a. ______________________ b. ______________________

## Written Test

7. Identify the ports of a full function valve. Write your answers in the blanks below.



a. ____________________ b. ____________________

c. ____________________ d. ____________________

Permission to duplicate this test is granted.

# Trailer Air Brake Systems
## Unit 5-C

### Answers to Written Test

1. a. 4
   b. 9
   c. 3
   d. 8
   e. 1
   f. 2
   g. 7
   h. 5
   i. 6

2. a. Emergency—Supplies emergency air to trailer; identified by red or "emergency" will be written on it

   b. Service—Sends signal to relay to apply brakes; identified by blue color or "service" will be written on it

3. a. Gladhand service/control
   b. Multi-function valve
   c. Reservoir

4. a. 5
   b. 6
   c. 1
   d. 4
   e. 3
   f. 2

5. a. Relay emergency valve
   b. Slack adjuster
   c. Gladhand emergency/supply

6. a. Full function valve
   b. Reservoirs

7. a. Spring brake exhaust port
   b. Service brake supply port
   c. Spring brake delivery port
   d. Reservoir nipple

# Trailer Air Brake Systems
## Unit 5-C

### Unit Evaluation Form

Student Name ______________________________ Unit Rating ____________

Assignment Sheet 1—Identify and Connect Components of a Trailer Full Function Air Brake System Rating ______

Comments: ______________________________________________

______________________________________________

Job Sheet 1—Inspect and Test Tractor Trailer Gladhands; Repair or Replace as Needed Rating ______

Comments: ______________________________________________

______________________________________________

Job Sheet 2—Inspect and Test Trailer Brake Full Function Valve; Replace as Needed Rating ______

Comments: ______________________________________________

______________________________________________

**Written Test Scores**

Pretest ________ Posttest ________ Other ________

Other ______________________________________________

______________________________________________

**Teacher Signature** ______________________________ Date ____________

**Student Signature** ______________________________ Date ____________

Permission to duplicate this form is granted.

# Diesel Technology

## Brakes

MAVCC

Student Edition

BEST COPY AVAILABLE

# Diesel Technology: Brakes

## Student Edition

Written by

Robert Hilley
Terry Scarberry
Mary Kellum

Project coordinated by

Mary Kellum
Jane Huston

Developed by

The Multistate Academic and Vocational Curriculum Consortium, Inc.
(MAVCC)
1500 West Seventh Avenue
Stillwater, Oklahoma 74074-4364

©2000

The Multistate Academic and Vocational Curriculum Consortium (MAVCC) does not discriminate on the basis of race, creed, color, national origin, sex, age, religion, veteran status, or qualified handicap.

# *Diesel Technology: Brakes*

Student Edition

## Table of Contents

**SECTION A: INTRODUCTION** **DT:B**

Unit 1-A: Introduction to Brakes ........ A 1
Unit 2-A: Wheel Bearings and Seals ........ A 25
Unit 3-A: Antilock Brake Systems ........ A 47

**SECTION B: HYDRAULIC BRAKES**

Unit 1-B: Hydraulic Foundation Drum Brakes ........ B 1
Unit 2-B: Hydraulic Foundation Disc Brakes ........ B 23
Unit 3-B: Hydraulic System ........ B 43
Unit 4-B: Power Assist Units and Related Components ........ B 95

**SECTION C: AIR BRAKES**

Unit 1-C: Air Foundation Brakes ........ C 1
Unit 2-C: Air Supply System ........ C 47
Unit 3-C: Air Service Circuits ........ C 85
Unit 4-C: Special Circuits ........ C 115
Unit 5-C: Trailer Air Brake Systems ........ C 175

# Introduction to Brakes
# Unit 1-A

## Objective Sheet

**Unit Objective**

After completing this unit, the student should be able to diagnose basic brake system problems, move vehicle and prepare for service, check brake fluid level and condition, and inspect for leaks. The student should demonstrate these competencies by completing the assignment and job sheets and by scoring a minimum of 85 percent on the written test.

**Specific Objectives**

After completing this unit, the student should be able to:

1. Match terms related to brakes with their definitions.
2. State the purposes of the brake system.
3. Match scientific principles that affect brake systems with their definitions.
4. Match the types of brake systems with their descriptions.
5. Complete statements concerning the operation of a hydraulic brake system.
6. Arrange in order the steps in the operation of an air brake system.
7. Compare hydraulic and air brake systems.
8. Match types of brake fluid with their descriptions.
9. Distinguish between correct and incorrect guidelines for handling and storing brake fluid.
10. Distinguish between the purposes of troubleshooting and failure analysis.
11. Arrange in order the steps in failure analysis.
12. Describe the signs of brake failure.
13. Discuss the most common causes of brake failure.
14. Distinguish between correct and incorrect safety procedures to follow when working on brakes.
15. Complete statements concerning an overview of asbestos and safety guidelines to follow when working around asbestos.
16. Match specialty brake tools and equipment with their functions.
17. Diagnose and determine possible causes of general brake problems. (Assignment Sheet 1)
18. Identify features for assigned vehicle. (Assignment Sheet 2)
19. Move vehicle and prepare for service. (Job Sheet 1)
20. Check brake fluid level and condition and inspect for leaks. (Job Sheet 2)

# Introduction to Brakes
# Unit 1-A

## Information Sheet

1. Terms and definitions

    a. **Application time**—Time elapsed between depression of brake pedal (treadle) and engagement of the linings with the drums

    b. **Asbestos**—Class of magnesium-silicate minerals that occur in fibrous form

    c. **Asbestosis**—Permanent, untreatable lung scarring caused by exposure to asbestos; causes shortness of breath

    d. **Bleeding**—Process by which air and contaminants are removed from hydraulic system

    e. **Brake fluid**—Substance used to transmit force in hydraulic brake systems

    f. **Contaminate**—To make unfit for use by contact with foreign material

    g. **Corrode**—To weaken or destroy gradually by chemical means

    h. **Defect**—Imperfection that impairs value or usability

    i. **Failure**—Inability to perform the desired function; usually occurs prematurely or unexpectedly

    j. **Flushing**—Process of removing all old fluid from hydraulic system and replacing it with new fluid

    k. **Foreign material**—Any extraneous material not intended to be present

        Examples: Particles of steel, dirt, rust, carbon, acid, condensation (water)

    l. **Hydraulic**—Relating to the use of fluid to transmit force

    m. **Indicator**—Symptom that helps identify product, operation, or maintenance problem

    n. **Physics**—Scientific study of matter and energy and how they interact

    o. **Pneumatic**—Relating to the use of air to transmit force

    p. **Release time**—Time between release of brake pedal and total disengagement of brake linings and brake drums

    q. **Root cause**—Specific condition that started the problem

    r. **Stopping distance**—Distance a vehicle travels from the time force is applied to brake control until vehicle reaches a full stop

    s. **Wear**—Undesirable removal of material from the surface of a part

## Information Sheet

2. **Purposes of the brake system**

   a. To slow the vehicle

   b. To stop the vehicle

   c. To hold the vehicle when stopped

   d. To provide an emergency means of stopping the vehicle

3. **Scientific principles that affect brake systems** (the physics of braking)

   a. **Energy**—Ability to do work; types include mechanical, electrical, light, heat, nuclear

   b. **Force**—Applied energy that causes change in the motion or shape of an object

   Example: Pressing the brake pedal starts a series of mechanical energy conversions that stop the movement of the vehicle and that also produce heat and sound energy.

   c. **Work**—Movement as a result of applied force

   d. **Power**—Rate at which work is done or energy is transmitted; measured in horsepower, torque, or watts

   e. **Motion/movement**—State of an object changing its location in space

   f. **Velocity or speed**—Rate of motion

   g. **Acceleration/deceleration**—Change in velocity

   h. **Momentum**—Property of a moving body (mass x velocity) that determines the amount of force and the length of time required to bring it to rest

   i. **Friction**—Resistance to movement between two objects in contact with each other

   Note: For a truck traveling on a flat road, if you let up on the accelerator, the friction between the road and the truck tires will eventually cause the truck to stop. Brake technology uses this principle to slow or stop the truck by increasing the friction on the wheels through the use of brake shoes or pads (friction materials).

   j. **Gravity**—Force that one mass exerts on another; most familiar source is the Earth

   Note: Gravity is what makes a water balloon dropped from a building fall and what makes a truck going downhill gain speed. The force of gravity helps pull the truck downhill. However, when it comes to braking, gravity makes it harder to stop the truck going downhill. More braking force is required. Less force is required to stop a truck going uphill because gravity acts with braking friction to overcome the force of the moving truck.

## Information Sheet

4. **Types of brake systems**

   a. **Mechanical**—Uses gears, levers, cables, and similar devices to transfer force through the brake system

   b. **Electrical**—Uses electromagnetic force to transfer force through the brake system

   c. **Hydraulic**—Uses brake fluid to transfer force through the brake system

   d. **Air**—Uses air to transfer force through the brake system

   e. **Engine**—Uses electrical and hydraulic components to eliminate engine's power stroke so that engine power is retarded

5. **Operation of a hydraulic brake system**

   a. Brake fluid is stored in a reservoir called a master cylinder and in brake lines connecting the master cylinder to the wheel cylinders.

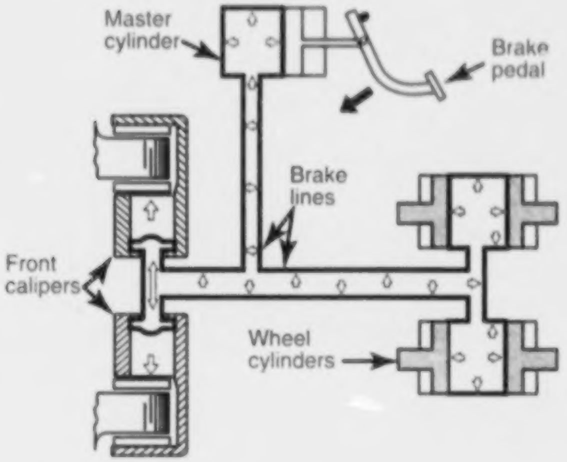
   b. Depressing the brake pedal forces a pushrod to move one or more pistons in the master cylinder to seal the fluid between the master cylinder and the wheel cylinders.

   c. Additional pressure on the brake pedal pushes the pistons in the wheel cylinders, which then causes the brake shoes/pads to press against the wheels. This increased friction causes the wheels to slow and eventually stop if pressure continues to be applied.

   d. When the brake pedal is released, springs return the master cylinder pistons to their open position so that the brake fluid is no longer under pressure.

   e. With the pressure released, the pistons in the wheel cylinders move back into their cylinders with the force returning to zero pressure.

   Figure 1



## Information Sheet

### 6. Operation of an air brake system

a. An air compressor pressurizes air and stores it in air tanks.

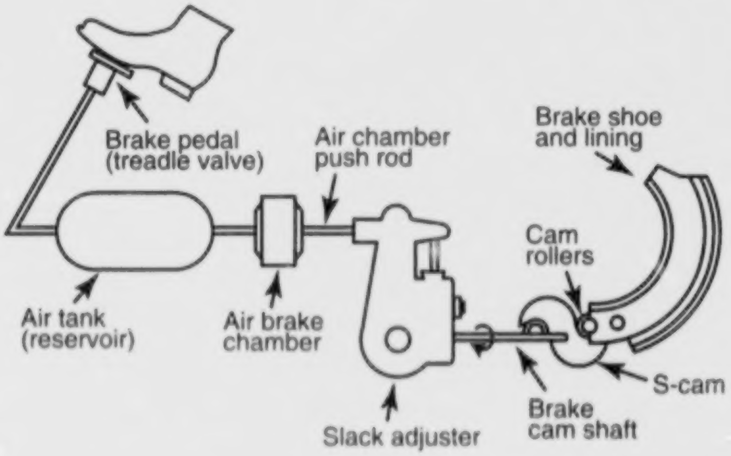
b. Depressing the brake pedal releases pressurized air from the tanks, which is then applied to the piston in the air brake chamber.

c. Movement of the piston actuates a lever (slack adjuster), which rotates the s-cam.

d. This causes the brake shoes to make contact with the brake drum. Friction between the shoes and the drum causes the wheels to slow and eventually stop if pressure continues to be applied.

e. When the brake pedal is released, air is exhausted from the air brake chambers and springs return the shoes to their released position.

Figure 2


Brake pedal (treadle valve)
Air chamber push rod
Brake shoe and lining
Cam rollers
Air tank (reservoir)
Air brake chamber
S-cam
Brake cam shaft
Slack adjuster

Courtesy of Haldex Midland Services

## Information Sheet

7. **Comparison of hydraulic and air brake systems**

| Characteristics | Hydraulic Brakes | Air Brakes |
|---|---|---|
| Application time (time to engage) | Faster | Slower (due to the time needed for the air to move through the system—Brake lag) |
| Release time | Faster | Slower |
| Pressure leak | Will lead to loss of braking | Will not lead to loss of braking |
| Maintenance | Require little maintenance | Require moderate maintenance including draining of air tanks |
| Adaptability | Difficult to expand | Fairly easy to expand and to tie to other systems, such as trailers |
| Fail-safe (back up) system | Available | Available |

8. **Types of brake fluid and their descriptions**

   a. DOT 3

      1) Glycol-based fluid that is clear or amber tinted

      2) Lowest boiling point of the three types described

      3) When exposed to air, absorbs moisture very quickly

   b. DOT 4

      1) Glycol-based fluid that is clear or amber tinted

      2) Higher boiling point than DOT 3

      3) When exposed to air, absorbs moisture more slowly than DOT 3

   c. DOT 5

      1) Synthetic, silicon-based fluid that is purple tinted

      2) Highest boiling point of the three types described

      3) Does not absorb moisture when exposed to air

      4) Incompatible with other fluids. Do not mix with DOT 3 or 4.

## Information Sheet

### 9. Guidelines for handling and storing brake fluid

a. Change the brake fluid at each major brake repair.

b. Take care not to spill brake fluid on brake linings or any chrome or painted surfaces as it will damage these finishes.

c. Always keep brake fluid clean; do not allow any foreign material or petroleum products (gasoline, kerosene, oil, grease) to get into the fluid.

d. Do not use brake fluid as a substitute for other fluids such as power steering fluid or automatic transmission fluid (ATF).

e. Never use containers contaminated with grease, oil, dirt, rust, etc. Always clean off top of the fluid reservoir before refilling it in order to avoid contamination.

f. Keep the exposure time to air as short as possible for glycol-based brake fluids. This will prevent moisture from being drawn from the air which can deteriorate the fluid's boiling point properties.

Note: Moisture contamination and a reduced boiling point can lead to vapor lock.

g. To prevent absorption of moisture, tightly cap fluid containers after use, and keep master cylinder tightly covered. Reinstall cover immediately after filling master cylinder with new fluid. Also keep fluid reservoir in pressure brake bleeder tightly closed except when refilling.

h. Always replace the brake fluid when you suspect moisture contamination in the hydraulic brake lines.

i. Use the smallest possible can of brake fluid to fill master cylinder. Use two small cans rather than half a large can.

j. Store brake fluid away from heat or flame, as it is highly flammable.

k. Avoid skin and eye contact. Wash with soap and water if skin contact occurs. In case of eye contact, immediately wash eyes for 15 minutes and call a physician or poison control for additional instructions.

### 10. Purposes of troubleshooting and failure analysis

a. **Troubleshooting**—To find and correct the problem

Example: While inspecting a wheel bearing, you find a cracked race, so you replace the bearing.

b. **Failure analysis**—To find the root cause of the problem and to correct both the cause and the problem

Example: While inspecting a wheel bearing, you find a cracked race. After examining the service records and the internal parts of the wheel bearing, you trace the root cause of the problem to be improper installation of the bearing by the previous service technician. The same technician installed the two previous bearings which failed prematurely. You install a new bearing and notify your instructor/supervisor so the other technician's installation methods can be corrected.

## Information Sheet

11. **Steps in failure analysis**

    a. Obtain information about the circumstances surrounding the failure.

       1) Talk to the operator.

       2) Find out what was going on when the failure happened. What are the symptoms?

    b. Operate the vehicle (if possible) to learn more about the vehicle and to identify the problem.

       1) Check the brake pedal and overall operation of the brake system.

       2) Check the maintenance and service records of the vehicle. Have any parts been recently changed? Is there a reoccurring problem?

    c. Refer to the manufacturer's troubleshooting guide to list the probable root causes for the problem(s) you have identified.

    d. Inspect the vehicle to gather and organize facts. This is the preliminary examination.

       1) Check for any visible clues such as leaks, cracks, broken wires, and overall condition of the underside of the vehicle.

       2) Check lines and fittings for cracks, damage, leaks, kinks, twists, bubbles, and chafing.

    e. Perform detailed examination, if necessary and recommended by manufacturer, to narrow down the root cause.

       1) This usually involves the disassembly of the affected portion of the brake system.

       2) Note any parts that are loose, excessively worn, discolored, misaligned, damaged, or in other ways unusual.

       3) Compare system to what normal system should look like. Look for anything unusual.

       4) Check for contamination in the system.

    f. Select most probable root cause based on total evidence.

    g. Communicate with your supervisor/instructor and/or owner/operator/customer about your conclusion.

    h. Make repairs/replacements as directed and approved.

    i. Test and operate vehicle to make sure problem is corrected. If not, go back to list of possible causes and decide on the next most likely cause. Repeat remaining steps until problem is solved.

    j. Follow up with customer to make sure problem is corrected and customer is satisfied.

## Information Sheet

### 12. Signs of brake failure

a. **No braking**—When the driver actuates the brakes, there is no evidence of the vehicle slowing or stopping

b. **Improper brake pedal feel**—When the driver presses the brake pedal, its movement or response is not normal

Examples: Pedal goes to floor, pedal does not move

c. **Improper vehicle motion**—When the brakes are applied, the vehicle vibrates excessively, pulls to one side, lunges, or otherwise handles erratically

d. **Audible signs**—When the brakes are applied, unexpected noises occur or expected noises do not occur

e. **Visible signs**—Cracks, leaks, smoke, or other indications that can be seen by the operator or service technician

f. **Instrument indicators**—Warning lights and displays in the vehicle that alert the driver to malfunctions

### 13. Most common causes of brake failure

a. Defective or incorrect parts installed

Examples: Hoses that expand during brake application, weak diaphragm return springs, wrong size piston seals

b. Improper service of brake system

Examples: Poor bleeding, improper shoe adjustment, loose fittings

c. Improper service of related systems

Examples: Improperly tuned engine on vacuum power assist unit, low power steering fluid level on hydraulic power assist unit

d. Overheating

Examples: Heavy braking, excessive braking, clogged rotor ventilators

e. For hydraulic brakes—Improper or inadequate brake fluid

Examples: Improper brake fluid, low brake fluid, contaminated brake fluid (including air bubble contamination)

f. For air brakes—Contaminants in air system or air leaks

Examples: Dirty or moisture-laden air in the system

## Information Sheet

### 14. Safety procedures to follow when working on brakes

a. **General rules for servicing the vehicle:**

1) Read and follow the manufacturer's instructions for servicing the vehicle.

2) Use only the recommended tools and replacement parts or supplies specified by the manufacturer.

3) Follow all safety precautions identified by the manufacturer.

4) Wear personal protective equipment (safety glasses, gloves, hearing protection) as required.

5) Use proper lifting techniques and lifting devices, such as wheel dollies and stands, when moving or holding heavy components.

b. **Special rules for servicing pressurized systems:**

1) Both hydraulic and air brake systems operate under pressure. Therefore, use great care around either system. Compressed springs and pressurized lines can deliver great force.

2) Always block the truck-tractor and trailer wheels prior to working on the vehicle. Do not rely on the brake system to hold the vehicle.

3) Release the pressure from pressurized lines (air or hydraulic) gradually and completely before working on the vehicle.

4) Follow the manufacturer's special disassembly procedures for pressurized components and systems. Note any warning tags on brake components, especially the spring brake.

**Caution: If used improperly, the spring brake can release enough pressure to cause death, severe personal injury, and/or property damage!**

c. **Rules for moving/driving a vehicle:**

1) Be sure vehicle is out of gear before starting it.

2) Use extreme caution when moving a vehicle in the shop. Check around the vehicle and the planned path to make sure there are no obstacles in the way.

3) Make sure you have a current commercial driver's license (CDL) and/or other state and school requirements before driving a vehicle on the road.

Note: Most schools require a current CDL and documented safety tests of your driving ability. However, some schools will not allow students to test drive a vehicle under any circumstances.

4) Before driving any vehicle, check fluid levels, adjust seat and mirror, and fasten your seat belt.

5) Do not road test vehicle if the brake warning light is lit.

## Information Sheet

### 15. Overview of asbestos and safety guidelines to follow when working around asbestos

a. Because some brake linings contain asbestos, it is important that you know the potential hazards of asbestos and the precautions to take to protect yourself.

b. Exposure to airborne asbestos dust can cause serious and possibly fatal lung diseases, especially asbestosis and lung cancer. The damage accumulates over the years; symptoms are usually not seen for 15 or more years.

c. Most new brake linings do not contain asbestos. However, the materials used instead of asbestos (glass, ceramics, mineral wool, and carbon) still pose health hazards to your lungs, although they should be safer than asbestos. Health experts do not agree about the potential long-term risks from working with and inhaling non-asbestos fibers. Therefore, it is best if you continue to follow the safety guidelines for working with asbestos, even if the brake linings are no longer made of asbestos.

d. The most important things to remember are:

   1) Avoid creating asbestos (or non-asbestos) dust when working on brakes.

   2) Avoid breathing any dust accidentally created.

The following rules will help you accomplish these most important goals.

e. Always use OSHA-approved brake cleaning equipment. In the diesel technology shop, there are two preferred methods that should be used for all brake and clutch inspection, disassembly, repair, and assembly:

   1) Negative pressure enclosure vacuum system with HEPA (high efficiency particulate air) filters; also used with air-purifying respirators

   2) Low pressure/wet cleaning brake cleaning equipment (more common)

f. Never use compressed air or dry brushing to clean brake parts or assemblies.

g. Read the material safety data sheets for any products containing asbestos, as required by OSHA, and follow any additional safety precautions they recommend.

h. When cleaning the brake work area, use a damp mop on the floor and a damp rag on all countertops to remove any remaining dust. This helps prevent asbestos fibers from becoming airborne.

i. Do not grind or machine brake linings. This is specialty work that requires additional precautions because contact with fiber dust is higher during these operations.

j. Wash your hands before eating, drinking, or smoking.

k. Do not wear asbestos-contaminated work clothes home. These should be cleaned with special vacuums and then laundered separately.

l. To protect others in the shop, brake work areas should be separated from other operations if possible.

## Information Sheet

16. **Specialty brake tools and equipment and their functions**

    a. **Asbestos removal system**—Used to prevent contamination from asbestos or non-asbestos dust

    b. **Bearing packer**—Used to force grease into wheel bearings

    c. **Bearing race installer**—Used to drive bearing race into wheel hub

    d. **Brake adjusting tool**—Used to adjust clearance between brake drum and brake shoe

    e. **Brake bleeder**—Used as pressure tank to automatically bleed hydraulic system

    f. **Brake rotor gauge**—Used to measure thickness of rotor

    g. **Brake shoe retaining spring tool**—Used to remove and install retaining spring clips

    h. **Brake spring tool**—Used to remove and install shoe return springs on drum brakes

    i. **Disc caliper tool**—Used to compress disc caliper pistons

    j. **Drum brake gauge**—Used to determine proper clearance between brake lining and drum

    k. **Metering valve tool**—Holds metering valve open to allow pressure bleeding of front disc brakes

    l. **Pressure gauge**—Used to check the operation of a proportioning valve

    m. **Seal installer**—Used as a driver to install wheel seal into hub

    n. **Seal ring installer**—Used to drive wear ring on axle

    o. **Tube flaring set**—Used to form ends of tubing to allow installation of connector fittings

    p. **Tubing bender**—Allows bending of metal tubing without kinking

    q. **Wheel cylinder hone**—Used to resurface wheel cylinders to remove corrosion and slight pitting

    r. **Wheel dolly**—Used to lift, move, or hold heavy wheel components

# Introduction to Brakes
## Unit 1-A

### Assignment Sheet 1—Diagnose and Determine Possible Causes of General Brake Problems

Name ______________________________ Overall Rating ____________

| | |
|---|---|
| **Evaluation Criteria** | **Rating** |
| Correct choice of service manual and section | ______ |
| Correct identification of possible causes | ______ |

Directions: Use the appropriate service manuals and troubleshooting guides to diagnose and determine one possible cause for each of the following problems.

**Part A: Hydraulic brakes**

1. Low pedal ______________________________
2. Soft (spongy) pedal ______________________________
3. Brake failure warning light on ______________________________
4. Uneven braking (pulling) ______________________________
5. Dragging ______________________________
6. Poor stopping ______________________________

**Part B: Air brakes**

1. Poor stopping ______________________________
2. Uneven braking (pulling) ______________________________
3. Grabbing ______________________________
4. Parking brakes won't release ______________________________
5. Slow build-up time ______________________________
6. Too much air loss with brake application ______________________________

# Introduction to Brakes
## Unit 1-A

### Assignment Sheet 2—Identify Features for Assigned Vehicle

Name ______________________ Overall Rating __________

| | |
|---|---|
| **Evaluation Criteria** | **Rating** |
| Correct identification of possible features | ______ |
| Correct use of reference manuals | ______ |

Directions: Your instructor will provide you with access to a heavy-duty vehicle. Inspect the vehicle's cab and refer to the owner's manual, maintenance log, and/or service manual to identify the information requested. Record your answers in the blanks provided.

1. Make and model of vehicle ______________________
2. Vehicle identification number ______________________
3. Type of brake system ______________________
4. Parking brake method ______________________
5. List all gauges located in the cab. ______________________
6. List all warning lights located in the cab. ______________________
7. List any override switches/buttons that must be engaged before the engine can be started.

## Assignment Sheet 2

8. Locate the gear shifting pattern, and draw a picture of it below.

9. Number of transmission speeds ______________________________

10. Date and description of last brake service ______________________________

______________________________________________

______________________________________________

# Introduction to Brakes
## Unit 1-A

### Job Sheet 1—Move Vehicle and Prepare for Service

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

| **Evaluation Criteria** | **Rating** |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Operator's manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Correct information is obtained | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Vehicle
2. Flashlight
3. Operator's manual

B. Procedure

☐ 1. Study the operator's manual.

☐ 2. Approach the vehicle and notice its general condition.

☐ 3. Look under the vehicle for fresh oil, coolant, grease, or fuel leaks. Use a flashlight as needed.

☐ 4. Check the area around the vehicle for hazards to vehicle movement such as people, other vehicles, objects, low hanging wires, or limbs.

☐ 5. Get into the vehicle's cab using the hand holds and steps provided.

☐ 6. Adjust the seat and mirrors (inside and outside).

☐ 7. Identify the type of brake system used.

☐ 8. Check the dash or instrument panel to locate important gauges such as oil gauge, fuel gauge, water temperature gauge, and air pressure gauge.

☐ 9. Check for any special instructions needed for starting the engine.

☐ 10. Make sure the transmission is in neutral.

## Job Sheet 1

☐ 11. Start the engine and listen for unusual noises.

☐ 12. Look at the gauges and make sure the oil pressure comes up to normal.

☐ 13. Warning lights and buzzers should go out right away. If equipped with air brakes, low air buzzers will stay on until air pressure comes up to about 60 psi.

☐ 14. After all buzzers go off, you are ready to move the vehicle.

☐ 15. Check transmission shift pattern.

☐ 16. Release parking brakes and put transmission in gear to move vehicle.

☐ 17. Make sure shop door is open all the way and the vehicle is not too high for the opening.

☐ 18. After you have moved the vehicle into the shop, set parking brake and put transmission in neutral. Then turn off ignition.

☐ 19. Return tools and materials to proper storage.

Evaluator's Comments: ______________________________

______________________________________________

______________________________________________

# Introduction to Brakes
# Unit 1-A

## Job Sheet 2—Check Brake Fluid Level and Condition and Inspect for Leaks

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

| **Evaluation Criteria** | **Rating** |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Specifications are checked | ______ |
| Adjustments/replacements/repairs are made | ______ |
| Job ticket is filled out properly | ______ |
| Cleanup is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Small clear glass container
5. Replacement brake fluid appropriate for system, if required
6. Equipment to bleed hydraulic system, if required
7. Vehicle with hydraulic brake system to be worked on
8. Others as recommended by instructor and equipment service manual

B. Guidelines

1. Be careful not to spill brake fluid on your skin or splash it in your eyes.

2. Be careful not to spill brake fluid on any painted surface of the vehicle, electrical connections, or brake linings. Clean up any spills on the floor immediately.

3. Do not allow brake fluid to be exposed to the air any longer than is necessary. This is to prevent the fluid from absorbing moisture from the air.

4. Make sure you use the type of brake fluid that is specified by the manufacturer, if any is required. Mixing of DOT 3 with DOT 4 is generally not recommended. DOT 5 should only be used if specifically recommended, and it should never be mixed with the other types.

5. Do not substitute any other fluid for brake fluid.

## Job Sheet 2

C. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Inspect the master cylinder, looking for leaks, external rust, damage, or other indications of problems.

☐ 4. Check the level of the brake fluid in the reservoir. Refer to the service manual for the appropriate level and how this is indicated on the system you are working on.

☐ 5. If the fluid level is noticeably low, this is generally an indication of a system problem, especially a leak.

  ☐ a. Search for the root cause if the fluid level is low.

  ☐ b. Make repairs/replacements as required to solve the problem.

☐ 6. Drain a small amount of the brake fluid into a clear glass container.

☐ 7. Examine the fluid for any signs of contamination. It should be fairly clear and uniform in color with no separation into distinct layers. Dark, cloudy, or thick fluid indicates contamination.

  ☐ a. Search for the root cause if contamination is found.

  ☐ b. Make repairs/replacements as required to solve the problem.

☐ 8. Also check the reservoir walls and floor for signs of rust, corrosion, and contaminants such as dirt, metal flakes, bits of rubber, and other debris.

☐ 9. If any leaks or contamination is found, flush the system, replace the brake fluid with new fluid of the type specified by the manufacturer, and bleed the system as directed by the manufacturer in the service manual.

Note: Refer to the appropriate job sheets in Section B of this book for the basic steps on how to perform these tasks. These will also be covered in the manufacturers' service manuals. These tasks are not necessary if the brake fluid is at the correct level (no leaks) and in good condition.

☐ 10. Turn in job ticket when finished.

☐ 11. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

______________________________

______________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| TOTAL PARTS/MATERIALS | | | |

## SPECIFICATIONS CHECKED

| | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |

School/Work Name ______________________
Address ______________________
Phone # ______________________

Date In ____________
Date Out ____________

## JOB TICKET

Customer Name ______________________
Customer Address ______________________
Customer Phone # ______________________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ______________________

Services/repairs made: ______________________

| LABOR | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

______________________ Date ____________

Technician ____________
Supervisor ____________

Unit 1-A, Job Ticket for Job Sheet 2

DT:B-A-23

# Wheel Bearings and Seals
# Unit 2-A

## Objective Sheet

### Unit Objective

After completing this unit, the student should be able to inspect, replace, and adjust wheel bearings and seals. The student should demonstrate these competencies by completing the assignment sheets and job sheet and by scoring a minimum of 85 percent on the written test.

### Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to wheel bearings and seals with their definitions.
2. List purposes of wheel bearings.
3. Label the parts of a wheel bearing.
4. Match the parts of wheel and hub assemblies with their illustrations.
5. Complete a chart of common wheel bearing defects and their causes and remedies.
6. List reasons for bearing failures.
7. Describe the results of various wheel bearing problems.
8. List types of wheel bearing lubricants.
9. Complete statements concerning guidelines for servicing wheel bearings.
10. Distinguish between correct and incorrect guidelines for adjusting wheel bearings.
11. List purposes of wheel seals.
12. List types of wheel seals.
13. Describe causes of sealing failure.
14. Complete statements concerning guidelines for installing wheel seals.
15. Evaluate worn and damaged wheel bearings and seals. (Assignment Sheet 1)
16. Select appropriate replacement wheel bearings and seals. (Assignment Sheet 2)
17. Remove, inspect, clean, replace, and adjust wheel bearings and seals. (Job Sheet 1)

# Wheel Bearings and Seals
## Unit 2-A

### Information Sheet

1. **Terms and definitions**

   a. **Axle (straight axle)**—Structural member attached to the suspension which connects the wheels and allows them to turn through a series of bearings

   b. **Bearing**—Part that helps spread the forces of a load to reduce the friction and wear of a moving part

   c. **Drive axle**—Axle whose shaft is splined to the differential drive gears which then rotates the wheel, hub, and tire assembly

   d. **End play**—Amount of lateral movement of the hub along the spindle due to clearance in the bearings

   e. **Full-floating drive axle**—Type of drive axle in which the axle housing carries the load of the vehicle, thereby allowing the bearings to "float"

   Note: This type of drive axle is designed for heavy duty applications.

   f. **Journal**—That part of a shaft, axle, or spindle that turns in a bearing

   g. **Overload**—In excess of designed load

   h. **Packing**—Act of forcing grease into wheel bearings

   i. **Preload**—Adjustment of bearings so that there is a slight load on them to ensure proper internal alignment and limiting of end play

   j. **Press fit**—Tight fit between mating parts; must be "pressed" into place

   k. **Races**—Tracks or channels in which something rolls or slides

   l. **Seal**—Material used to form a leakproof connection between moving or fixed parts

   m. **Spindle**—Small shaft or axle on which a wheel turns; also called steering knuckle

   n. **Steering axle**—Axle that contains a steering knuckle which allows the vehicle to be turned (steered)

   Note: This is typically the front axle.

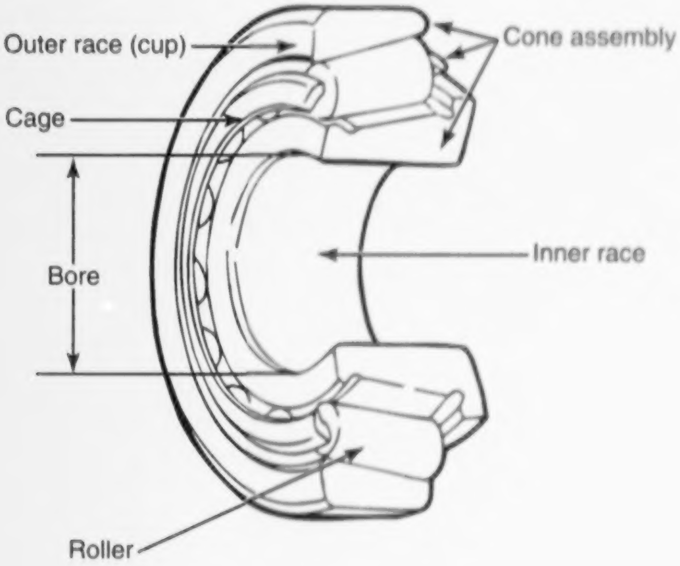
   o. **Wheel and hub assembly**—Assembly mounted on an axle in such a way that it rotates to allow movement of a vehicle

   p. **Wheel bearing**—Bearing used to distribute the load of a vehicle on its axles

## Information Sheet

2. **Purposes of wheel bearings**
    - a. To spread the weight of the vehicle and its load over a greater surface
    - b. To reduce the friction of wheel rotation
    - c. To reduce wear to parts
    - d. To provide a replaceable wear surface (wear ring)
3. **Parts of a wheel bearing (tapered roller shown)**

Figure 1

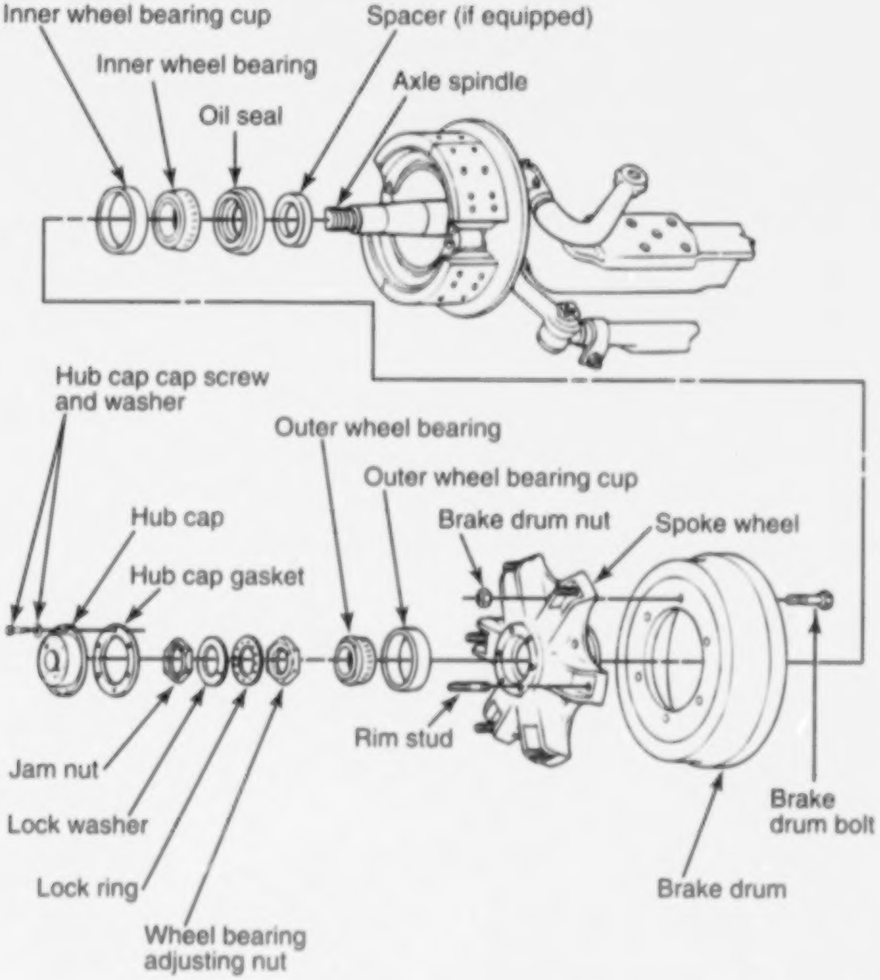

Outer race (cup)
Cone assembly
Cage
Bore
Inner race
Roller

## Information Sheet

**4. Parts of wheel and hub assemblies**

a. Axle assembly

Figure 2

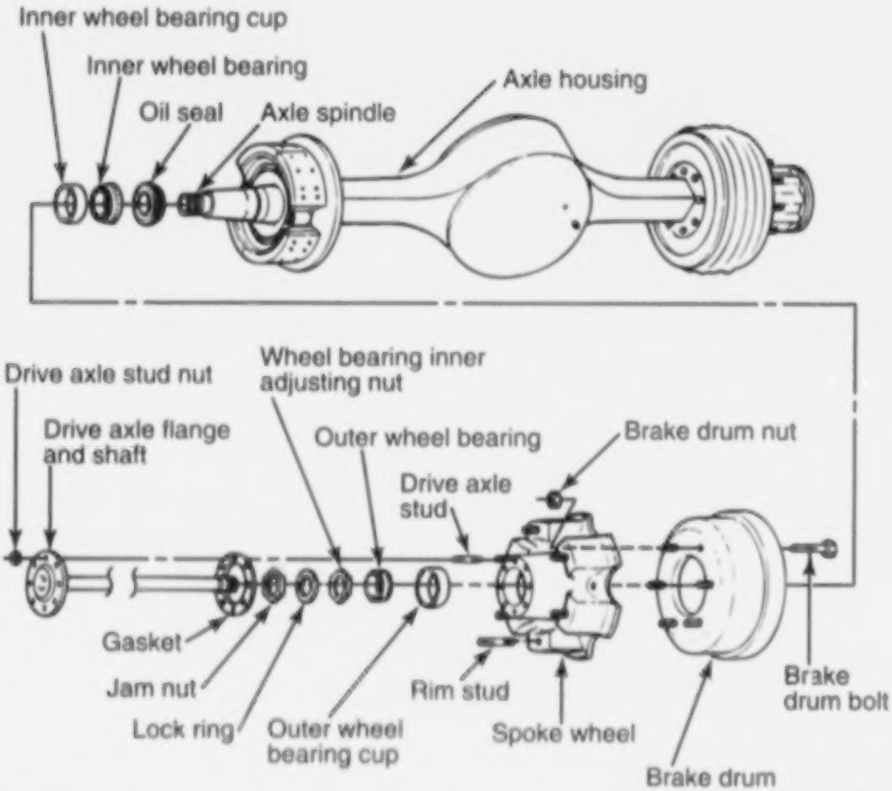

Inner wheel bearing cup
Inner wheel bearing
Oil seal
Spacer (if equipped)
Axle spindle
Hub cap cap screw and washer
Hub cap
Hub cap gasket
Outer wheel bearing
Outer wheel bearing cup
Brake drum nut
Spoke wheel
Rim stud
Jam nut
Lock washer
Lock ring
Wheel bearing adjusting nut
Brake drum bolt
Brake drum

Courtesy of Freightliner Corporation

## Information Sheet

b. Full-floating drive axle

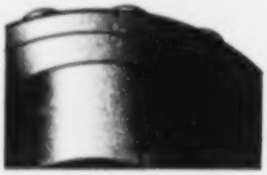
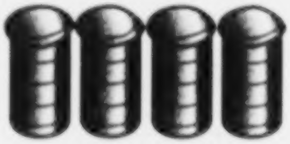
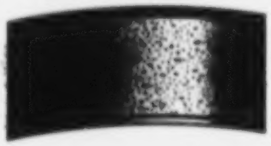
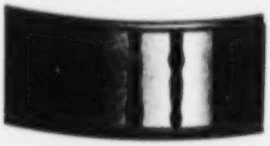
Figure 3


Inner wheel bearing cup
Inner wheel bearing
Oil seal
Axle spindle
Axle housing
Drive axle stud nut
Wheel bearing inner adjusting nut
Drive axle flange and shaft
Outer wheel bearing
Brake drum nut
Drive axle stud
Gasket
Jam nut
Lock ring
Outer wheel bearing cup
Rim stud
Spoke wheel
Brake drum bolt
Brake drum

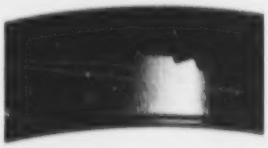
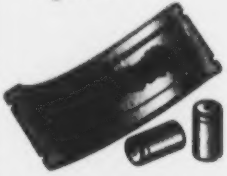
Courtesy of Freightliner Corporation

## Information Sheet

5. Common wheel bearing defects

| Name and Illustration of Defect | Description | Possible Cause | Remedy |
|---|---|---|---|
| a. **Mechanical damage**<br>Figure 4<br><br>Cracked inner race | Deforming or breaking of the bearing assembly | Mechanical stress, such as rough handling or improper fit | Replace bearing |
| b. **Abrasive wear**<br>Figure 5<br> | Wear on the rollers or races | Fine particles in the lubricant | Replace if wear is excessive or simply clean and repack if wear is minor |
| c. **Pitting**<br>Figure 6<br> | Surface indentations on races or rollers | Contamination with large particles | Clean and repack or replace if bearings are rough or noisy |
| d. **Brinelling**<br>Figure 7<br> | Surface indentations in the raceway that parallel the rollers | Excessive loading or vibration while the bearing is not rotating or improper installation | Generally replace bearing |

## Information Sheet

| Name and Illustration of Defect | Description | Possible Cause | Remedy |
|---|---|---|---|
| e. **Spalling**<br>Figure 8<br> | Flaking of the surface metal | Metal fatigue or poor quality bearings | Replace bearings |
| f. **Discoloration**<br>Figure 9<br> | Discoloration ranging from faint yellow to dark blue | Inadequate lubrication, overloading, or other source of excessive heat | Replace bearings |

6. **Reasons for bearing failures** (listed in order of frequency)

   a. Dirt

   b. Improper assembly

   c. Misalignment

   d. Insufficient, improper type, or inferior lubricants

   e. Overloading

   f. Corrosion

   g. Inferior material

   h. Incorrect grooving

   i. Incorrect clearance

   Note: Always inspect damaged bearings to determine cause of failure so that cause can be remedied before replacing bearings.

## Information Sheet

7. **Wheel bearing problems and their results**

   a. Loose or worn wheel bearings can cause

      1) Noise
      2) Vehicle pulling to one side
      3) Chatter
      4) Uneven braking
      5) Shimmy
      6) Too much play in steering system
      7) Shortened bearing and seal lives
      8) Misalignment of antilock brake wheel sensors

   b. Overtightened wheel bearings can cause

      1) Noise
      2) Uneven braking
      3) Overheating of wheel and bearing
      4) Vehicle pulling to one side

   c. Damaged wheel bearings can cause

      1) Noise
      2) Shimmy in affected wheel
      3) Vehicle pulling to one side

8. **Types of wheel bearing lubricants**

   a. Petroleum-based lubricants

      1) Grease
      2) Oil

   b. Synthetic lubricants

   Note: Use only the manufacturer's recommended lubricant, and check to make sure it is compatible with the seals being used.

## Information Sheet

### 9. Guidelines for servicing wheel bearings

a. Follow the vehicle manufacturer's recommendations for the selection and installation of wheel bearings.

b. Follow the bearing manufacturer's instructions for the selection and installation of lubricant.

c. Follow the vehicle manufacturer's recommendations for wheel bearing service intervals.

d. Compare the identification numbers of the old bearings and the replacement bearings. Do not destroy the old bearings until you record the identification numbers.

e. Every wheel has two sets of bearings—an inner bearing assembly and an outer bearing assembly. Be sure you don't install these backwards.

f. Keep bearing assemblies together as a set and do not exchange parts between different assemblies.

g. Use only an approved solvent to clean bearings.

h. If compressed air is used to clean bearings, use only low pressure and never enough pressure to turn the rollers.

**Caution: A bearing may fly apart if high pressure compressed air is used.**

i. Handle the bearings with care to prevent damage.

j. Observe asbestos exposure precautions because the removal and installation of wheel bearings may involve handling brake linings containing asbestos and other components contaminated with brake lining dust.

k. Do not reuse cotter pins removed from the spindle; always install a new cotter pin.

### 10. Guidelines for adjusting wheel bearings

a. Always follow the vehicle service manual procedure to adjust bearings.

b. Depending on the manufacturer, slight preload or limited end play may be recommended.

c. Adjustment of the wheel bearing will involve the use of either:

   1) Torque wrench to apply preload, or

   2) Dial indicator to adjust end play.

d. The numerous spindle-nut systems and hubs make it difficult to give general rules of thumb concerning appropriate preloading or end play amounts.

e. Always rotate wheel in both directions while torquing the adjusting nut.

f. While adjusting bearings, make sure that brakes do not drag on drum or rotor to produce a false adjustment.

## Information Sheet

g. Do not reuse locking devices (cotter pins, washers with tangs, etc.) that are deformed.

h. Adjust brakes after adjusting wheel bearings.

### 11. Purposes of wheel seals

a. To retain lubricants or liquids

b. To exclude dirt, water, and other contaminants

c. To separate dissimilar fluids (such as lubricating oil and water)

d. To confine pressure

### 12. Types of wheel seals

a. One-piece

  1) Unitized—Needs special driver

  2) Barrier—Installed with bare hand

b. Multipiece

  1) Lip seal—May have single or double lip

  2) Wear rings—May have flat ring or grit guard

### 13. Causes of sealing failure

Note: All seals will eventually fail and begin to leak with normal use. However, seals that fail prematurely are usually caused by one of the following:

a. **Improper installation techniques or careless handling**—Could result in nicked or cut sealing surfaces, scratched shaft, distorted or cocked seal, or damaged garter spring

b. **Incorrect seal used for application**

  1) Includes seals that are the wrong size; that are used in systems with excessive speeds, temperatures, or pressures; or that use fluids incompatible with the sealing material

  2) Could result in seals that are brittle, cracked, hardened, excessively worn, spongy, or blown-out

c. **Misalignment of shaft to bore**--Commonly results in excessive wear on one side of the seal

d. **Shaft or bore excessive roughness, scratches, burrs, or dirt**—Can result in excessive wear to the shaft, bore, and/or seal

## 14. Guidelines for installing wheel seals

a. Remove the old seal carefully. Take care when prying out the old seal not to scratch the housing. Sometimes you need a special puller.

b. Inspect the bore and shaft for nicks and burrs. File off any burrs that could cut the new seal.

c. Check shaft and bore dimensions to make sure they match the seal specifications.

d. Excessively worn or grooved shafts may be fitted with wear (repair) sleeves to create a new seal running surface. These require a special installation tool.

e. Never reuse old or damaged seals.

f. Make sure the new seal faces in the correct direction; usually the lip faces the lubricant or fluid to be retained.

g. Prelubricate the sealing element with the same lubricant being retained prior to installation.

h. Use the correct tool to install the seal. These include an arbor press, soft-face hammer, specially-made seal installer, or old bearing cup. Apply force evenly around the outer edge to avoid cocking the seal.

i. Check to see that the seal is fully seated and aligned in its bore. The manufacturer may specify how deep the seal must be installed.

j. Check and adjust the fluid level after installing a seal, and check for leaks.

# Wheel Bearings and Seals
## Unit 2-A

### Assignment Sheet 1—Evaluate Worn and Damaged Wheel Bearings and Seals

Name ______________________________ Overall Rating ____________

| Evaluation Criteria | Rating |
|---|---|
| Correct identification of wear in examples | ______ |
| Correct evaluation of reusability | ______ |
| Correct identification of failure in examples | ______ |
| Correct identification of root cause | ______ |
| Correct use of service manual and section | ______ |

Directions: Examine the six wheel bearings and seals (three of each) provided by your instructor. For each bearing or seal, identify and evaluate what you see and answer the questions that follow.

1. Wheel bearing #1

   Is wear present? __________ If so, describe the type of wear and its location. Is the wear normal or abnormal? Is the part reusable or does it need to be replaced?

   ______________________________________________________________

   ______________________________________________________________

   Are defects/failures present? __________ If so, describe the type of defect/failure and its location. What could have caused the defect/failure? Is the part reusable or does it need to be replaced?

   ______________________________________________________________

   ______________________________________________________________

2. Wheel bearing #2

   Is wear present? __________ If so, describe the type of wear and its location. Is the wear normal or abnormal? Is the part reusable or does it need to be replaced?

   ______________________________________________________________

   ______________________________________________________________

   Are defects/failures present? __________ If so, describe the type of defect/failure and its location. What could have caused the defect/failure? Is the part reusable or does it need to be replaced?

   ______________________________________________________________

   ______________________________________________________________

**Assignment Sheet 1**

3. Wheel bearing #3

   Is wear present? ____________ If so, describe the type of wear and its location. Is the wear normal or abnormal? Is the part reusable or does it need to be replaced?

   ______________________________________________________________________

   ______________________________________________________________________

   Are defects/failures present? ______________ If so, describe the type of defect/failure and its location. What could have caused the defect/failure? Is the part reusable or does it need to be replaced?

   ______________________________________________________________________

   ______________________________________________________________________

4. Wheel seal #1

   Is wear present? ____________ If so, describe the type of wear and its location. Is the wear normal or abnormal? Is the part reusable or does it need to be replaced?

   ______________________________________________________________________

   ______________________________________________________________________

   Are defects/failures present? ______________ If so, describe the type of defect/failure and its location. What could have caused the defect/failure? Is the part reusable or does it need to be replaced?

   ______________________________________________________________________

   ______________________________________________________________________

5. Wheel seal #2

   Is wear present? ____________ If so, describe the type of wear and its location. Is the wear normal or abnormal? Is the part reusable or does it need to be replaced?

   ______________________________________________________________________

   ______________________________________________________________________

   Are defects/failures present? ______________ If so, describe the type of defect/failure and its location. What could have caused the defect/failure? Is the part reusable or does it need to be replaced?

   ______________________________________________________________________

   ______________________________________________________________________

## Assignment Sheet 1

6. Wheel seal #3

Is wear present? ____________ If so, describe the type of wear and its location. Is the wear normal or abnormal? Is the part reusable or does it need to be replaced?

______________________________________________________________

______________________________________________________________

Are defects/failures present? ______________ If so, describe the type of defect/failure and its location. What could have caused the defect/failure? Is the part reusable or does it need to be replaced?

______________________________________________________________

______________________________________________________________

# Wheel Bearings and Seals
# Unit 2-A

## Assignment Sheet 2—Select Appropriate Replacement Wheel Bearings and Seals

Name ______________________ Overall Rating __________

| Evaluation Criteria | Rating |
|---|---|
| Directions are followed | ______ |
| Questions are answered correctly | ______ |

Introduction: An important skill in the service of brakes and wheel assemblies is the replacement of bearings and seals. There are numerous sizes and designs of seals and bearings, but to do their job properly the installed seals and bearings must be the correct parts for the vehicle. This assignment will provide you with practice in selecting those parts.

Directions: Your instructor will assign you one or more vehicles, either actual vehicles in your facility or vehicles identified by make and model. Use resources available in your shop to determine the following information about the wheel bearings and seals for the assigned vehicles.

1. Front wheels
    a. Bearings or bearing set part number(s) ______________________
    ______________________
    b. Recommended lubricant ______________________
    c. Seal part number ______________________
    d. Seal material ______________________
    e. Number of seal pieces ______________________
2. Rear wheels
    a. Bearings or bearing set part number(s) ______________________
    ______________________
    b. Recommended lubricant ______________________
    c. Seal part number ______________________
    d. Seal material ______________________
    e. Number of seal pieces ______________________

# Wheel Bearings and Seals
## Unit 2-A

### Job Sheet 1—Remove, Inspect, Clean, Replace, and Adjust Wheel Bearings and Seals

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

| Evaluation Criteria | Rating |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Proper tools, hydraulic floor jack, wheel dolly are used | ______ |
| Service manual is used properly | ______ |
| Steps are followed | ______ |
| Job ticket is filled out properly | ______ |
| Proper bearing and seals procedures are used | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Hydraulic floor jack
5. Wheel dolly (or jack stand)
6. Wheel chocks
7. Torque wrench
8. Dial indicator
9. Special wheel bearing and seal removal/installation tools as specified by manufacturer
10. Wheel assembly to be worked on—assigned by instructor
11. Others as recommended by instructor and equipment service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Set parking brake and/or chock wheels so vehicle will not roll.

☐ 4. Raise wheel using a hydraulic floor jack.

☐ 5. Position wheel dolly under wheel to support the wheel. Make sure that wheel rotates freely.

☐ 6. Identify the method used to lubricate the wheel bearings—oil or grease.

## Job Sheet 1

☐ 7. For front wheel or trailer, remove hub cap. For drive axle, remove axle according to manufacturer's directions.

☐ 8. Remove outer nut and lock assembly. Then remove inner nut.

☐ 9. Pull the wheel assembly off the spindle or axle housing.

☐ 10. Remove wheel seal as directed by manufacturer.

☐ 11. Remove old bearings (inner and outer) from hub as specified by manufacturer.

☐ 12. Clean and inspect wheel bearings.

☐ 13. Clean and inspect bearing races inside the hub.

☐ 14. Have instructor check your work so far. Discuss replacements needed.

Bench check ____________________

☐ 15. If bearings need to be replaced, remove races from hub as instructed by manufacturer.

☐ 16. Lubricate wheel bearings as specified.

☐ 17. Use reverse procedure to reassemble wheel on spindle using new parts as approved. Record on job ticket.

☐ 18. Adjust bearings as specified by manufacturer. Check preload or end play specifications.

☐ 19. Have instructor check your work.

Final check _____________

☐ 20. Turn in job ticket when finished.

☐ 21. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ____________________________________________

__________________________________________________________________

__________________________________________________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| TOTAL PARTS/MATERIALS | | | |

## SPECIFICATIONS CHECKED

| | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |

School/Work Name ____________________
Address ____________________
Phone # ____________________

Date In ____________
Date Out ____________

## JOB TICKET

Customer Name ____________________
Customer Address ____________________
Customer Phone # ____________________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ____________________

Services/repairs made: ____________________

| LABOR | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds these estimates in time or cost.

____________________ Date ____________

Technician ____________
Supervisor ____________

Unit 2-A, Job Ticket for Job Sheet 1

DT:B-A-45

# Antilock Brake Systems
# Unit 3-A

## Objective Sheet

### Unit Objective

After completing this unit, the student should be able to diagnose and troubleshoot antilock brake system problems as well as inspect, test, and service an antilock brake system. The student should demonstrate these competencies by completing the assignment and job sheets and by scoring a minimum of 85 percent on the written test.

### Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to antilock brake systems (ABS) with their definitions.
2. State the purposes of an antilock brake system.
3. Match the basic parts of an antilock brake system with their functions.
4. Arrange in order the steps in the basic operation of an antilock brake system.
5. List two ways to describe antilock brake systems.
6. Complete an ABS time line.
7. Match methods of testing ABS valves with their descriptions.
8. Describe the most common problems associated with antilock brake systems.
9. Discuss the signs of antilock brake failure.
10. Diagnose and determine possible causes of ABS problems. (Assignment Sheet 1)
11. Inspect, test, and service an antilock brake system. (Job Sheet 1)
12. Troubleshoot antilock brake system problems. (Job Sheet 2)

# Antilock Brake Systems
# Unit 3-A

## Information Sheet

1. **Terms and definitions**

   a. **Antilock braking system (ABS)**—Part of the service brake system that automatically controls the amount of rotational wheel slip during braking

   b. **Coefficient of friction**—Grip that a tire has on a particular surface; the higher the number, the greater the friction and the greater the stopping ability

   Examples: Low friction surfaces—Wet, icy, or snow-covered highways
   High friction surface—Dry concrete pavement

   c. **Federal Motor Vehicle Safety Standards (FMVSS)**—Federal requirements that apply to vehicles, including their brake systems and antilock brake systems

   Note: FMVSS 105 governs hydraulic and electric brakes; FMVSS 121 governs air brakes. Both standards address antilock brake systems.

   d. **Jackknife**—Skid condition in which the tractor-trailer combination brake at different speeds, ultimately forming a 90° bend

   e. **Light-emitting diode (LED)**—Electronic device that puts out light when a voltage is applied to it; commonly used on electronic displays

   f. **Lock-up**—Condition in which the brakes have stopped the wheels but the momentum of the moving vehicle causes it to continue to move (skid)

   g. **Modulate**—To adjust or regulate a value (such as wheel speed) within a desired range

   h. **National Highway Traffic Safety Administration (NHTSA)**—Federal agency that monitors highway safety and mandates safety regulations

   i. **Sensor**—Electronic device that responds to a physical stimulus (such as heat, light, movement, pressure, etc.) and then transmits a signal to a control device

   j. **Skid**—Continued movement of the vehicle after wheel lock-up

   k. **Split-coefficient surfaces**—Road conditions where one wheel's side of the lane has a very different coefficient of friction from the other wheel's side

   Example: Left half of lane is wet, but right half is icy or has icy patches.

   l. **Traction**—Adhesive friction between the tire and the surface on which it moves

   m. **Traction control**—Optional feature available on some antilock brake systems that applies braking force to a wheel that spins as a result of low traction

   n. **Transitional surfaces**—Road conditions that are quickly changing from one coefficient of friction to another

   Examples: Icy to wet, dry to wet, gravel to asphalt

   o. **Wheel slip**—Difference between vehicle speed and wheel speed, expressed as a percentage

## Information Sheet

2. **Purposes of an antilock brake system**

Note: Although ABS is called upon for less than 5% of vehicle brake applications, it offers great advantage over conventional braking on low friction, split-coefficient, and transitional surfaces where wheels typically skid or lock.

a. To prevent wheels from locking up such as during panic stops

b. To prevent wheels from skidding such as on slippery road surface

c. To prevent jackknives when driving a combination vehicle

d. To maintain vehicle stability and steering control

3. **Basic parts of an antilock brake system and their functions**

a. **Exciters, tone rings, or toothed wheels** (various names)

1) Are rings with notches or teeth that are read or sensed by the wheel speed sensor

2) Are generally installed in the foundation brake area on the wheel or hub shaft

b. **Wheel speed sensors**

1) Are electromagnetic devices mounted at the wheel end or inside an axle which combine with the exciter ring to measure wheel speed and transmit the information to the ECU

2) Consist of two per sensed axle

c. **Modulator (control) valves**

1) Are solenoid-type valves actuated by the ECU

2) Are located either at each wheel or on an axle set to meter the amount of air pressure to each brake or the axle's brakes

3) Are designed so they do not alter the pneumatic balance of the foundation brakes under normal braking

4) Are also called the ABS valves

Note: Some manufacturers also add relay valves to modulate ABS valves.

d. **Electronic control unit (ECU) or controller**

1) Is a microcomputer that controls the operation of the ABS

2) Receives information constantly from each wheel sensor and sends information to the modulator valves to control brake pressure if a wheel tries to lock during braking

e. **Warning light (lamp)**

1) Indicates the status of the antilock brake system to driver and service technician

2) Is usually located on the dash of a truck/tractor and/or the front of a trailer

## Information Sheet

f. **Wiring harness**

1) Used to connect the antilock system parts

2) Consists of an arrangement of electrical wires with insulation and terminals for connections

4. **Basic operation of an antilock brake system**

a. Exciter (toothed) ring rotates with wheel.

b. Wheel sensor works with exciter to generate an electrical signal regarding wheel and vehicle speed which is sent to the ECU.

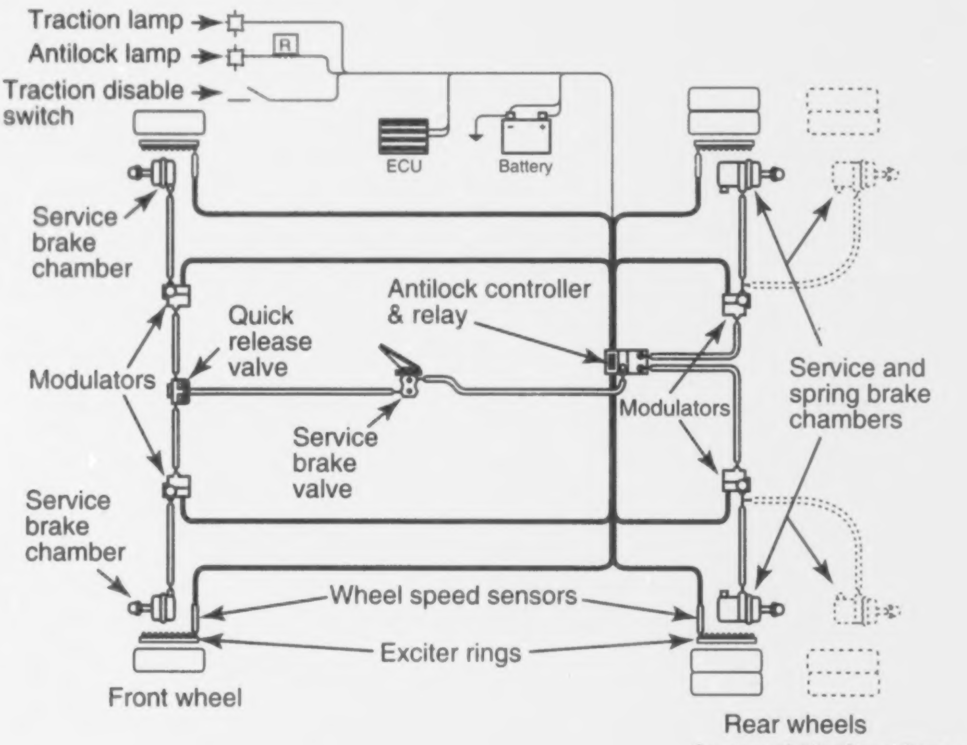
c. ECU constantly compares the actual wheel speed signal to the ideal wheel parameter identified in the ECU.

1) If ECU interprets information as normal (within range), operation continues.

2) If ECU interprets new information as abnormal (wheels are turning at different speeds), a new signal is sent to the modulator or relay valve at the wheel.

d. Modulator responds to ECU message and adjusts braking force.

Figure 1—Typical antilock brake system


Traction lamp
Antilock lamp
R
Traction disable switch
ECU
Battery
Service brake chamber
Antilock controller & relay
Quick release valve
Modulators
Modulators
Service and spring brake chambers
Service brake valve
Service brake chamber
Wheel speed sensors
Exciter rings
Front wheel
Rear wheels

Courtesy of AlliedSignal Bendix

## Information Sheet

5. **Ways to describe antilock brake systems**

   a. **By number of channels**—Number of ABS modulators

   Example: 2 channel system has 2 ABS modulators.

   b. **By alphanumeric descriptors**—Number of sensors (S) and number of modulators (M)

   Examples: 2S/1M (2 sensors, 1 modulator), 2S/2M (2 sensors, 2 modulators), 4S/2M (4 sensors, 2 modulators)

6. **ABS time line**

| Dates | Actions |
|---|---|
| 1974 | FMVSS 121 rule takes effect requiring specific brake performance on all new air-braked vehicles. ABS is designed to meet new requirements. |
| 1978 | Federal Court sets aside stopping distance requirement, thereby ending use of first-generation ABS devices. |
| 1979–1988 | NHTSA begins research on second generation of ABS; fleet testing begins. |
| 1991–1993 | Congress orders DOT/NHTSA to pursue ABS rule. National Transportation Safety Board recommends mandating ABS. NHTSA publishes advanced notice of rulemaking. |
| 1995 | NHTSA issues final ABS rule, "Stability and Control Requirements for Medium and Heavy Vehicles." |
| 1997 | From March 1, all new air-braked tractors must have ABS. |
| 1998 | From March 1, all new air-braked trailers must have ABS. |
| 1999 | From March 1, all new air-braked straight trucks, buses, dollies, and trailers must have ABS. |
| 1999 | From March 1, all new hydraulically-braked straight trucks and buses over 10,000-lb. GVWR must have ABS. |
| 2001 | From March 1, dash-mounted trailer ABS warning light is required. |
| 2009 | From March 1, external ABS warning lights are no longer required on new trailers and dollies. |

## Information Sheet

### 7. Methods of testing ABS valves

Note: All of these tests are manufacturer-specific. Consult the appropriate manufacturer's service manual for more information.

a. **Test blow-down sequence**

1) Is a quick function check of the pneumatic valves of the ABS system

2) Is performed in the following way:

    a) Apply and hold the brake pedal while the ignition is in the OFF position.

    b) While continuing to hold the pedal down, turn the ignition to the ON position. (It is not necessary to start engine.)

    c) Listen for exhaust "pop" of the application valves.

3) Cannot be performed on all systems; even among those that do pop, not all systems pop in the same order.

b. **Check diagnostic display**

1) Is a check for fault codes stored in the electronic control unit (ECU) if the system has on-board or remote diagnostic displays or devices

2) Involves the use of manufacturer's fault code lists to identify specific problems

3) May use flashing blink codes or LED bar code lights to indicate the problem, or may require electronic diagnostic readers/scan tools or computers/PCs to diagnose the problem

c. **Check dash panel light sequence or trailer indicator lamp**

1) Is observed as the ignition key is turned to the ON position

2) Provides the driver or service technician with a quick check of the electrical components of the ABS system

3) Light sequence varies by manufacturer and build date of the vehicle.

    Examples:
    1. Light goes on-off-on; then when vehicle is moved, light goes off.
    2. Light goes on-off each time the brake pedal is applied (trailer systems)

4) Variations such as continuous ON or continuous OFF indicate a system fault.

## Information Sheet

8. **Most common problems associated with antilock brake systems**

    a. Wheel sensors out of adjustment (usually excessive air gap between exciter ring and sensor)

        1) May be caused by excessive wheel end play from out-of-adjustment wheel bearings

        2) May be displaced during service on nearby parts or by freezing/refreezing of ice and snow

    b. Worn or damaged sensor or modulator

    c. Loose, damaged, or corroded wiring and/or connectors

    d. Faulty warning indicator lights

    e. Non-functioning ECU

9. **Signs of antilock brake failure**

    a. **Improper vehicle motion**—When brakes are applied on slippery surfaces, vehicle skids, plows out, locks up, or experiences trailer swing. Antilock brakes do not operate.

    b. **Improper ABS braking**—Antilock system is activated unnecessarily, when normal braking should be possible.

    c. **Visible signs of ABS damage**—Cracks, leaks, frayed wires, or other indications can be seen by driver or service technician.

    d. **Instrument indicators**—Warning lights and diagnostic displays alert the driver or service technician to malfunctions.

# Antilock Brake Systems
# Unit 3-A

## Assignment Sheet 1—Diagnose and Determine Possible Causes of ABS Problems

Name ______________________ Overall Rating ____________

| **Evaluation Criteria** | **Rating** |
|---|---|
| Correct choice of service manual and section | ______ |
| Correct identification of possible cause | ______ |

Directions: Use the appropriate service manuals and troubleshooting guides to diagnose and determine one possible cause for each of the following ABS problems.

1. Poor stopping ______________________
2. Wheel lockup or skidding ______________________
3. Pulsation (felt in brake pedal) ______________________
4. Excessive or unusual noise ______________________
5. ABS warning light stays on continuously ______________________
6. ABS warning light turns on and off intermittently while driving ______________________
7. ABS warning light never lights up ______________________

# Antilock Brake Systems
## Unit 3-A

### Job Sheet 1—Inspect, Test, and Service an Antilock Brake System

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

| Evaluation Criteria | Rating |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Specifications are checked | ______ |
| Adjustments/replacements/repairs are made | ______ |
| Job ticket is filled out properly | ______ |
| Cleanup is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Approved cleaning supplies and materials
5. Approved electronic test equipment (scan tools, diagnostic data link, computer, connecting cables, etc. as specified by manufacturer)
6. Approved replacement parts
7. Vehicle with antilock brake system to be worked on
8. Others—as recommended by instructor and equipment service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Inspect the antilock brake system, including all components, for damage, wear, and proper connections. At the same time, you should be looking for evidence of any leaks or other brake system problems.

☐ 4. Clean components of any dirt or corrosion found using only approved cleaning materials and methods.

## Job Sheet 1

☐ 5. Test the operation of the antilock brake system as specified by the manufacturer.

  ☐ a. This may involve a road test to check the warning light sequence at start-up and above a certain speed. Check with your instructor for approval if road testing is necessary.

**CAUTION: Follow all safety precautions when driving an unfamiliar vehicle. Drive approved route in case there is a breakdown.**

  ☐ b. Other tests involve scan tools or other diagnostic equipment to check any fault codes that may be stored in the system. Use only the equipment and procedures approved by the manufacturer.

☐ 6. Record all test results on the job ticket.

☐ 7. Check and (if necessary) adjust the air gap between the wheel speed sensors and the exciter (toothed) ring as described by the manufacturer.

☐ 8. Service the antilock brake system by correcting any fault codes identified, repairing any damaged wires or connections, and replacing any faulty parts.

☐ 9. Double check the system to make sure any problems identified have been corrected. This may involve another short road test.

☐ 10. When all problems have been corrected, you may then clear all fault codes stored in the system's memory as described by the manufacturer.

☐ 11. Turn in job ticket when finished.

☐ 12. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ____________________________________________

______________________________________________________________

______________________________________________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| TOTAL PARTS/MATERIALS | | | |

## SPECIFICATIONS CHECKED

| | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |

School/Work Name ____________________

Address ____________________

Phone # ____________________

Date In ____________

Date Out ____________

## JOB TICKET

Customer Name ____________________

Customer Address ____________________

Customer Phone # ____________________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ____________________

Services/repairs made: ____________________

| | LABOR | |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

____________________ Date ____________

Technician ____________

Supervisor ____________

Unit 3-A, Job Ticket for Job Sheet 1

DT:B-A-59

# Antilock Brake Systems
# Unit 3-A

## Job Sheet 2—Troubleshoot Antilock Brake System Problems

Name ______________________ Attempt Number ______________

Date ______________________ Overall Rating ______________

| **Evaluation Criteria** | **Rating** |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Specifications are checked | ______ |
| Adjustments/replacements/repairs are made | ______ |
| Job ticket is filled out properly | ______ |
| Cleanup is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual and troubleshooting guide
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Approved cleaning supplies and materials
5. Approved electronic test equipment (scan tools, diagnostic data link, computer, connecting cables, etc. as specified by manufacturer)
6. Approved replacement parts
7. Vehicle with antilock brake system with existing problem(s) to be worked on
8. Others—as recommended by instructor and equipment service manual

B. Procedure

Note: You will be assigned by your instructor a vehicle with a problem(s) that is most likely to be in the antilock brake system. Your task is to identify and correct the problem.

☐ 1. Locate and follow the appropriate troubleshooting procedure in the service manual or troubleshooting guide.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Talk to the driver about the problem, and ask questions to identify the most probable cause of the problem.

Examples: What happened? When did it start? How often does it happen? How long does it last? Under what conditions? (certain speeds, certain temperatures, certain roads) Is it constant or occasional (intermittent)? What happens to the ABS warning light?

## Job Sheet 2

☐ 4. Check the manufacturer's service manual or troubleshooting guide for the problem(s) you suspect. Identify the types of tests that will be required and what symptoms you are looking for when you inspect and road test the vehicle.

☐ 5. Visually inspect the vehicle's entire brake system, including the antilock system. Look for leaks, cracks, missing or broken parts, loose connections, and damaged wiring.

☐ 6. Ask your instructor for approval to road test the vehicle.

**CAUTION: Follow all safety precautions when driving an unfamiliar vehicle. Drive approved route in case there is a breakdown.**

☐ 7. Perform tests (road and shop) suggested by service manual. Look and listen for unusual sounds, vibrations, braking ability, and warning light sequences. Some tests will require the use of scan tools and/or computers for diagnosis of electronic fault codes. Follow the manufacturer's instructions for these tests.

☐ 8. Record all test results on the job ticket.

☐ 9. Service the antilock brake system by correcting any fault codes identified, repairing any damaged wires or connections, and replacing any faulty parts.

☐ 10. Double check the system to make sure any problems identified have been corrected. This typically involves another short road test.

☐ 11. When all problems have been corrected, clear all fault codes stored in the system's memory as described by the manufacturer.

☐ 12. Turn in job ticket when finished.

☐ 13. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

______________________________

______________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| TOTAL PARTS/MATERIALS | | | |

## SPECIFICATIONS CHECKED

| | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |

School/Work Name ____________________

Address ____________________

Phone # ____________________

Date In __________

Date Out __________

## JOB TICKET

Customer Name ____________________

Customer Address ____________________

Customer Phone # ____________________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ____________________

| Services/repairs made: | LABOR | |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

____________________ Date __________

Technician __________

Supervisor __________

Unit 3-A, Job Ticket for Job Sheet 2

DT:B-A-63

# Hydraulic Foundation Drum Brakes
# Unit 1-B

## Objective Sheet

### Unit Objective

After completing this unit, the student should be able to perform routine service of drum brake assemblies. The student should demonstrate these competencies by completing the job sheets and by scoring a minimum of 85 percent on the written test.

### Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to hydraulic foundation drum brakes with their definitions.
2. Identify the components of a drum brake assembly.
3. Match the components of a drum brake assembly with their functions.
4. Match drum and hub assembly defects with their descriptions.
5. Label the parts of a brake shoe.
6. Match the parts of a brake shoe with their functions.
7. Distinguish between types of brake shoe applications.
8. Distinguish between types of brake shoe materials.
9. Match brake shoe defects with their descriptions.
10. Match drum brake hardware with their uses.
11. Complete statements concerning the adjustment of drum brake assemblies.
12. List conditions to inspect in drum brake adjustment systems.
13. Remove, clean, inspect, and measure a brake drum. (Job Sheet 1)
14. Remove, inspect, and replace brake shoes and related hardware. (Job Sheet 2)
15. Replace brake drum and adjust brake clearance. (Job Sheet 3)

# Hydraulic Foundation Drum Brakes
## Unit 1-B

### Information Sheet

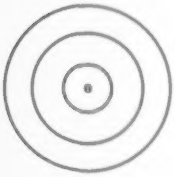
1. **Terms and definitions**

   a. **Adjust**—To position parts relative to each other for most efficient operation

   b. **Cam**—Mechanical part in which a circle is enlarged in one area so that the rotation of the part causes movement of another part when the enlarged area contacts the other part

   c. **Concentric**—Referring to circles that share a common center

   Figure 1

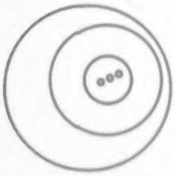


   Note: The drum and hub assembly consists of circles that are intended to be concentric.

   d. **Drum**—Part of wheel assembly which is engaged by the brakes to slow or stop the vehicle

   e. **Eccentric**—Referring to circles that have different centers

   Figure 2



   f. **Foundation brakes**—Mechanical components that provide braking force

   g. **Frayed**—Deterioration of a cable in which individual strands of the cable are broken or worn

   h. **Machine**—To use lathes, drills, or other equipment to change the shape or surface finish of metal

   i. **Orientation**—Positioning of a part relative to the vehicle and to other parts

## Information Sheet

j. **Self-energizing**—Term applied to braking system whose design allows braking force to be multiplied by friction

k. **Shoe-to-drum clearance**—Distance between the shoes and the drum when the vehicle is moving

l. **Strut**—Shaped metal part used in brake systems to hold brake shoes apart

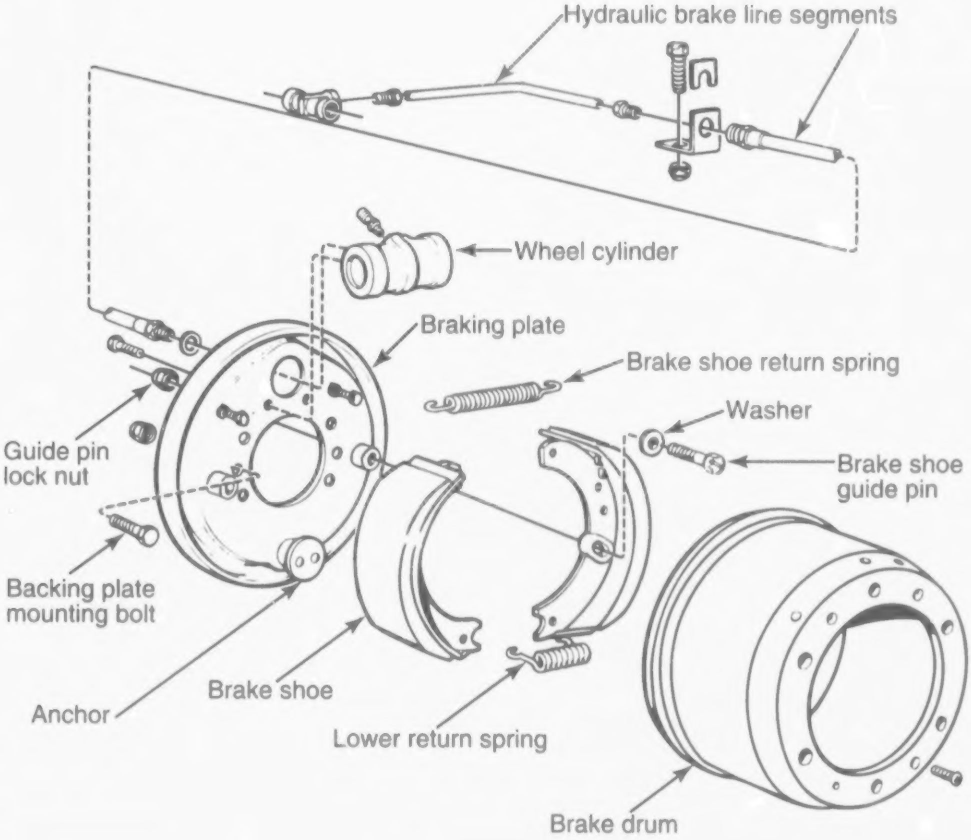
m. **Tempered**—Condition of being hardened by the application of heat

n. **Wallowing**—Condition of a hole becoming enlarged due to wear from a part moving loosely inside it

o. **Warp**—To become deformed as a result of excessive heat or pressure

### 2. Components of a drum brake assembly

Figure 3


Hydraulic brake line segments
Wheel cylinder
Braking plate
Brake shoe return spring
Washer
Brake shoe guide pin
Guide pin lock nut
Backing plate mounting bolt
Anchor
Brake shoe
Lower return spring
Brake drum

Courtesy of Haldex Midland Services

## Information Sheet

### 3. Functions of drum brake assembly components

a. **Brake drum**—Serves as portion of wheel assembly against which the brake shoes apply pressure to stop the rotation of the wheel

b. **Backing plate**—Provides base for drum brake assembly onto which other parts are mounted

c. **Primary shoe**—Exerts pressure on the inside of the drum on the side of the brake assembly toward the front of a forward moving vehicle

Note: The primary shoe is also referred to as the forward or the leading shoe.

d. **Secondary shoe**—Exerts pressure on the inside of the drum on the side of the brake assembly toward the rear of a forward moving vehicle

Note: The secondary shoe is also referred to as the reverse or trailing shoe.

e. **Wheel cylinder**—Transfers force from the movement of the brake pedal to cause one or both shoes to be pressed against the drum

f. **Hold-down**—Holds the shoe to the backing plate while allowing limited movement of the shoe; may be springs, bolts, guide pins, or clips

g. **Anchor**—Holds one end of the shoes in place to allow the shoes to pivot to make contact with the brake drum; may be single or double

h. **Shoe spring**—Returns shoes to unactuated position

i. **Adjuster hardware**—Provides means of adjusting the clearance between the shoe and the drum when the shoes are not actuated for braking

### 4. Drum and hub assembly defects

Note: Whenever the wheels are serviced, the drum and hub assembly should be inspected for the following conditions. If the assembly is removed, it should be measured and inspected. The measurement should check drum diameter and out-of-round or eccentric conditions.

a. **Improper wheel mounting hardware (studs and nuts)**—May be missing, loose, rusted, stripped, or damaged

b. **Cracks or breaks in the drum**—Separation of metal or missing metal

c. **Heat checking**—Thin cracks in the surface of the drum braking surface

d. **Hard spotting**—Tempered areas of metal that become visible when the drum is machined

e. **Eccentric condition**—Center of the hub and center of the outside of the drum are not the same

f. **Out-of-round condition**—Drum or hub diameter is not equal around entire assembly

g. **Incorrect diameter**—Inside diameter of drum is not within acceptable tolerance

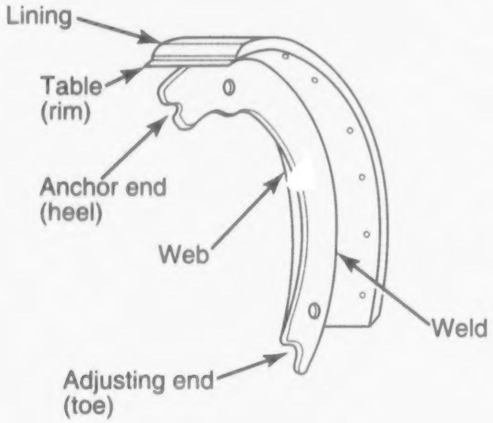
## Information Sheet

h. **Scoring**—Scratches and cuts in the surface of the drum

i. **Bell-mouthed condition**—Uneven wear of the drum leading to a greater diameter on the inboard side of the drum

5. **Parts of a brake shoe**

Figure 4



6. **Functions of brake shoe parts**

a. **Lining**—Contacts drum to provide friction to stop wheel rotation

b. **Table (rim)**—Provides a surface to which the lining can be mounted

c.. **Web**—Reinforces table and provides means of mounting hardware for brake operation

d. **Weld**—Binds table and web together

e. **Anchor end (heel)**—Positions shoe and prevents shoe from rotating with drum

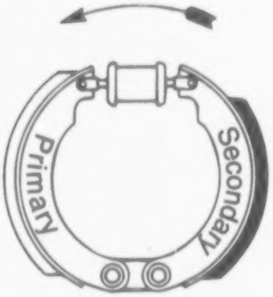
f. **Adjusting end (toe)**—Allows installation of the adjusting device

## Information Sheet

### 7. Types of brake shoe applications

a. **Non-servo**—As brake is applied, the shoes apply force independently because of the bottom anchor

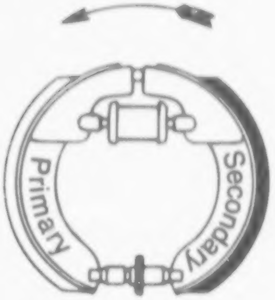
Figure 5



Courtesy of Haldex Midland Services

b. **Single cylinder duo-servo**—Has dual wheel cylinder pistons that apply equal force on the primary and secondary shoes; force is multiplied by the rotation of primary shoe against the secondary shoe forcing against the brake drum

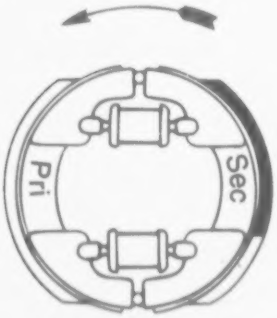
Figure 6



Courtesy of Haldex Midland Services

c. **Double cylinder**—Has double wheel piston cups applying equal force in both directions at both ends of the shoes

Figure 7



Courtesy of Haldex Midland Services

## Information Sheet

8. **Brake shoe materials**

    a. **Semimetallic**

    1) Consist of aluminum, lead, silicas, and other ingredients mixed with resin and molded into shape

    2) Used for severe duty only

    b. **Organic**

    1) Consist of fiber, organic materials, and resins/bonding agents

    2) Most commonly used type

9. **Brake shoe defects**

    a. **Excessive wear**—Inadequate lining remains for proper braking

    b. **Oil or grease contamination**—Areas of the lining are coated with oil or grease, which can lead to softened material or reduced friction between the lining and the drum

    c. **Glazing**—Surface of the shoe lining is hard and smooth

    d. **Scoring**—Surface of the shoe lining contains cuts and streaks

    e. **Gouging**—Surface of the shoe lining contains relatively deep scratches or pits

    f. **Cracks**—Surface of the shoe lining contains fine cracks

    g. **Shoe deformities**—Bending, wear, or warping of the table or web of the shoe

10. **Drum brake hardware and their uses**

    a. **Springs**—Position movable parts, such as holding parts in relation to one another or returning a part to a previous position

    Examples: Shoe return spring, adjuster spring

    b. **Clips**—Hold parts together where excessive pressure is not a problem

    Examples: Shoe hold-down clips and cups, retainer clips, antirattle clips

    c. **Pins**—Provide stationary mounting point or positioning guide

    Examples: Anchor pins, guide pins

    d. **Levers**—Transmit force from one part to another through a pivoting motion

    Examples: Adjuster levers, parking brake levers

    e. **Cables and links**—Transmit force from one part to another with a pulling motion

    Examples: Parking brake cable, adjuster cable, adjuster link

## Information Sheet

f. **Adjuster hardware**—Provides means of adjusting position of shoes

Note: Springs and clips should not be reused. Other parts may be reused if not deformed or worn.

### 11. Adjustment of drum brake assemblies

a. The clearance between shoe and drum is adjusted using a manual or automatic adjustment mechanism.

b. Manual adjustment mechanism may use star wheels or centric adjusting devices to lengthen or shorten the clearance distance.

c. Manual adjustment mechanism is a periodic maintenance item.

d. Automatic adjustment mechanisms commonly use cables or links that turn the star wheel as the lining wears.

e. If the system is equipped with an automatic adjuster, the automatic system usually has to be disengaged to allow manual adjustment.

### 12. Conditions to inspect in drum brake adjustment systems

a. Manual adjustment

1) Teeth on star wheel

2) Threads on adjusting screw and pivot nut

3) Improper seating of slots

4) Freedom of movement in star wheel, cam, or other adjustment mechanism

5) Access plug is installed

b. Automatic adjustment

1) Adjustment mechanism engages adjuster

Examples: Lever engages star wheel

2) Linkages free of wear

Examples: Frayed cables, worn wedges

3) Linkages free of deformities and damage

Examples: Links bent, ratchet teeth broken

4) Free movement of all parts

5) Operation of related parts

# Hydraulic Foundation Drum Brakes
## Unit 1-B

### Job Sheet 1—Remove, Clean, Inspect, and Measure a Brake Drum

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

| Evaluation Criteria | Rating |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately; defects are identified | ______ |
| Specifications are checked | ______ |
| Correct measurements are obtained | ______ |
| Job ticket is filled out properly | ______ |
| Clean-up is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Jack and jack stands
6. Wheel dolly
7. Brake adjusting tool
8. High pressure washer
9. Vehicle with hydraulic foundation drum brakes to be worked on
10. Others as recommended by instructor and equipment service manual

B. Procedure

Note: Refer to Job Sheet 1, Unit 1-A, if you need to move the vehicle into the shop.

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Apply the parking brake.

☐ 4. Block the vehicle wheels.

☐ 5. Jack up vehicle and install safety stands.

☐ 6. If removing rear brake drums, release parking brake.

## Job Sheet 1

☐ 7. Back off brake adjuster until wheel turns freely.

☐ 8. Remove bearing hub cap or axle.

☐ 9. Loosen wheel bearing lock nuts.

☐ 10. Move wheel dolly in place and remove wheel assembly.

☐ 11. Clean brake drum with high pressure washer.

☐ 12. Inspect brake drum for cracks and wear.

☐ 13. Measure drum dimensions and record measurements on job ticket/work order.

☐ 14. Turn in job ticket when finished.

☐ 15. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

______________________________

______________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE | |
|---|---|---|---|
| | | | |
| | TOTAL PARTS/MATERIALS | | |

### SPECIFICATIONS CHECKED

| | |
|---|---|
| | |

School/Work Name ____________________
Address ____________________
Phone # ____________________

Date In ____________
Date Out ____________

## JOB TICKET

Customer Name ____________________
Customer Address ____________________
Customer Phone # ____________________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ____________________

Services/repairs made: ____________________

| LABOR | |
|---|---|
| | |

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

____________________ Date ____________

Technician ____________
Supervisor ____________

Unit 1-B, Job Ticket for Job Sheet 1

DT:B-B-13

# Hydraulic Foundation Drum Brakes
## Unit 1-B

### Job Sheet 2—Remove, Inspect, and Replace Brake Shoes and Related Hardware

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

| **Evaluation Criteria** | **Rating** |
|---|---|
| Directions are followed | |
| Safety procedures are followed | |
| Service manual is used properly | |
| Parts are inspected accurately; defects are identified | |
| Specifications are checked | |
| Adjustments/replacements/repairs are made | |
| Job ticket is filled out properly | |
| Clean-up is adequate | |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Jack and jack stands
6. Brake spring tool
7. Brake washing equipment
8. Vehicle with hydraulic foundation drum brakes to be worked on
9. Others as recommended by instructor and equipment service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

Note: Steps 2–6 may already be done if you are continuing the work started in Job Sheet 1.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Move vehicle into shop.

☐ 4. Block wheels.

☐ 5. Jack up vehicle and install safety stands.

## Job Sheet 2

☐ 6. Remove brake drum. Refer to Job Sheet 1, Unit 1-B, or the service manual if assistance is needed.

☐ 7. Clean brake shoes and hardware with approved brake cleaning equipment. Do not use compressed air.

☐ 8. Remove return springs.

☐ 9. Remove hold-down springs and clips.

☐ 10. Inspect shoes and hardware.

☐ 11. Record findings on job ticket/work order.

☐ 12. If new shoes are needed, do not discard old shoes. You may need to exchange.

☐ 13. Reinstall brake shoes and hardware on backing plate.

☐ 14. Make sure adjusting screw is adjusted all the way in.

☐ 15. Turn in job ticket when finished.

☐ 16. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ____________________________________________

____________________________________________________________

____________________________________________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| TOTAL PARTS/MATERIALS | | | |

## SPECIFICATIONS CHECKED

| | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |

School/Work Name ____________________

Address ____________________

Phone # ____________________

Date In ____________________

Date Out ____________________

## JOB TICKET

Customer Name ____________________

Customer Address ____________________

Customer Phone # ____________________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ____________________

Services/repairs made: ____________________

| LABOR | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

____________________ Date ____________

Technician ____________________

Supervisor ____________________

Unit 1-B, Job Ticket for Job Sheet 2

DT:B-B-17

# Hydraulic Foundation Drum Brakes
## Unit 1-B

### Job Sheet 3—Replace Brake Drum and Adjust Brake Clearance

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

| Evaluation Criteria | Rating |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Specifications are checked | ______ |
| Adjustments/replacements/repairs are made | ______ |
| Job ticket is filled out properly | ______ |
| Clean-up is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Jack and jack stands
6. Brake resetting gauge
7. Brake adjusting tool
8. Vehicle with hydraulic foundation drum brakes to be worked on
9. Others as recommended by instructor and equipment service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

Note: Steps 2–7 may already be done if you are continuing the work from Job Sheets 1 and 2.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Move vehicle into shop.

☐ 4. Block wheels.

☐ 5. Jack up vehicle and install safety stands.

☐ 6. Remove brake drum. (Job Sheet 1)

☐ 7. Remove, clean, and replace brake shoes. (Job Sheet 2)

### Job Sheet 3

☐ 8. If vehicle is equipped with inboard drums, remove the wheel bearing and seal.

☐ 9. Measure drum with resetting gauge.

☐ 10. Adjust shoe to match drum.

☐ 11. Install drum.

☐ 12. Remove the adjusting hole cover in the backing plate or the brake drum.

☐ 13. Turn the adjusting screw until the wheel can just be turned by hand.

☐ 14. Check to make sure the brake drag is equal at both wheels.

☐ 15. Install the adjusting hole cover in the backing plate.

☐ 16. Check brake pedal for travel to make sure brakes are working.

☐ 17. Remove jack stands.

☐ 18. Check operation of brakes.

☐ 19. Turn in job ticket when finished.

☐ 20. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________________________

______________________________________________________________

______________________________________________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE |
|---|---|---|
| | | |
| TOTAL PARTS/MATERIALS | | |

**SPECIFICATIONS CHECKED**

School/Work Name ______
Address ______
Phone # ______

Date In ______
Date Out ______

## JOB TICKET

Customer Name ______
Customer Address ______
Customer Phone # ______

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ______

Services/repairs made: ______

**LABOR**

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

______ Date ______

Technician ______
Supervisor ______

**Unit 1-B, Job Ticket for Job Sheet 3**

DT:B-B-21

# Hydraulic Foundation Disc Brakes
# Unit 2-B

## Objective Sheet

### Unit Objective

After completing this unit, the student should be able to perform routine service of disc brake assemblies. The student should demonstrate these competencies by completing the job sheets and by scoring a minimum of 85 percent on the written test.

### Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to hydraulic foundation disc brakes with their definitions.
2. Match the parts of a front disc brake with their illustrations.
3. Match the parts of a rear disc brake with their illustrations.
4. Identify the parts of a brake caliper.
5. Match the components of disc brake assemblies with their functions.
6. Describe the types of brake calipers.
7. Match rotor defects with their descriptions.
8. Describe the methods of assembling brake pads.
9. Match brake pad defects with their descriptions.
10. Describe the methods of determining wear on brake pads.
11. Describe the functions of noise suppressants and hardware components of a brake pad.
12. Distinguish between correct and incorrect safety guidelines for disc brake service.
13. Remove, clean, and inspect a caliper and pad assembly. (Job Sheet 1)
14. Inspect, measure, remove, and reinstall a rotor assembly. (Job Sheet 2)
15. Reinstall caliper and pad assembly and check brake operation. (Job Sheet 3)

# Hydraulic Foundation Disc Brakes
# Unit 2-B

## Information Sheet

1. **Terms and definitions**

   a. **Disc**—Circular metal component used in some brake system designs as the friction surface for the wheel assembly during braking

   b. **Noise suppressants**—Devices used in conjunction with brake assemblies to reduce the noise and vibration in the assembly

   Examples: Antirattle springs, antivibration clips

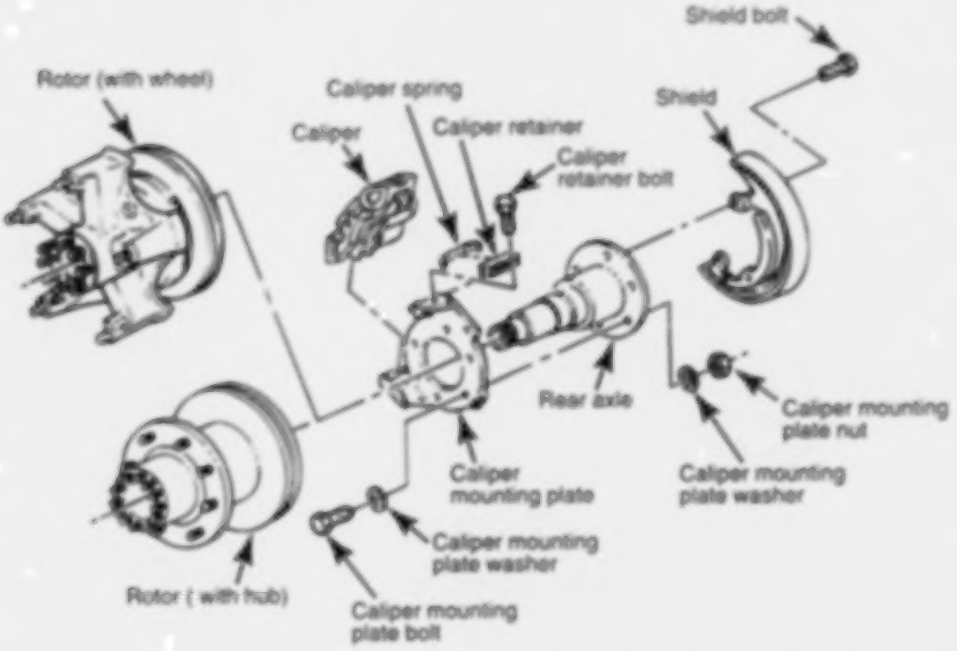
   c. **Recondition**—To restore to a like-new condition

   d. **Resurface**—To restore a surface to a specified (like-new) condition

   e. **Ventilated**— Disc brake design in which the rotor has vanes in the edge to dissipate heat

2. **Parts of a front disc brake**

Figure 1

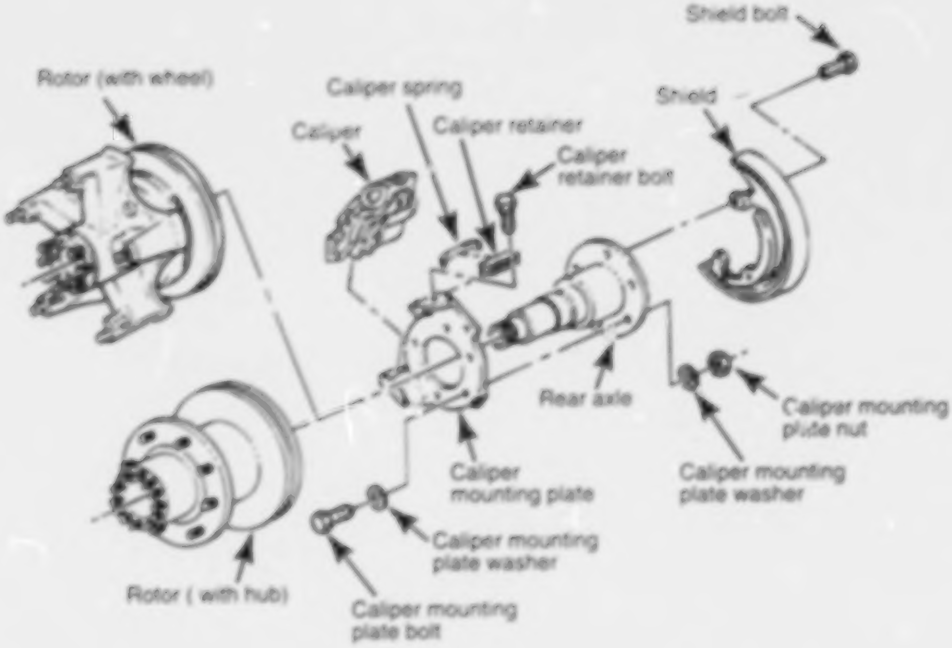

Shield bolt
Rotor (with wheel)
Caliper spring
Shield
Caliper
Caliper retainer
Caliper retainer bolt
Rear axle
Caliper mounting plate nut
Caliper mounting plate
Caliper mounting plate washer
Caliper mounting plate washer
Rotor ( with hub)
Caliper mounting plate bolt

*Reprinted with permission of General Motors Corporation

## Information Sheet

3. **Parts of a rear disc brake**

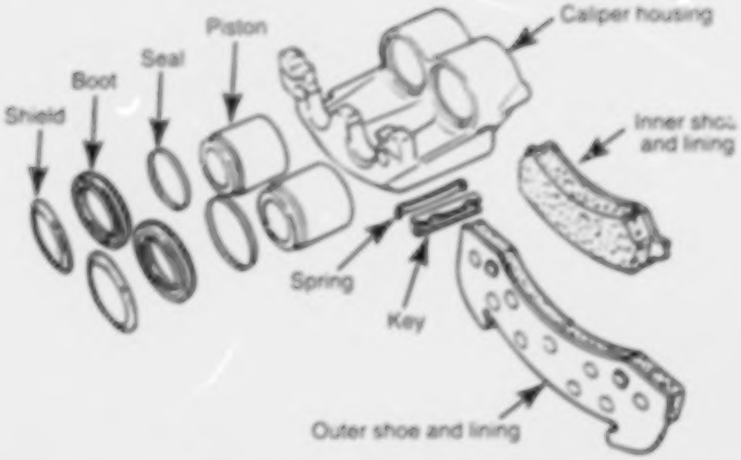
Figure 2


Shield bolt
Rotor (with wheel)
Caliper spring
Shield
Caliper
Caliper retainer
Caliper retainer bolt
Rear axle
Caliper mounting plate nut
Caliper mounting plate
Caliper mounting plate washer
Caliper mounting plate washer
Rotor ( with hub)
Caliper mounting plate bolt

Reprinted with permission of General Motors Corporation

4. **Parts of a brake caliper**

Figure 3


Caliper housing
Piston
Seal
Boot
Shield
Inner shoe and lining
Spring
Key
Outer shoe and lining

Reprinted with permission of General Motors Corporation

## Information Sheet

5. **Functions of disc brake assembly components**
    - a. **Rotor (disc)**—Provides portion of wheel assembly against which the brake pads apply pressure to stop the rotation of the wheel
    - b. **Caliper**—Houses the hydraulic piston and related hardware that actuates the pads
    - c. **Mounting plate and bolts**—Hold the caliper assembled
    - d. **Shield**—Protects rotor from foreign materials such as road ice or mud
    - e. **Caliper housing support**—Holds caliper in position over rotor
    - f. **Pads (shoes and linings)**—Exert pressure on the rotor
    - g. **Piston**—Transmits hydraulic force to the pads to push them against the rotor
6. **Types of brake calipers**
    - a. **Classified by installation method**
        - 1) **Floating**—Caliper is mounted on bolts through rubber bushings
        - 2) **Sliding**—Caliper is mounted in machined grooves that allow it to move from side to side in the caliper support
    - b. **Classified by piston count**
        - 1) **Single-piston**—One piston pushes the pad against the rotor
        - 2) **Double- (or dual-) piston**—Two pistons push the pad(s) against the rotor
7. **Rotor defects**
    - a. **Excessive runout**—Rotor does not run perpendicular to its axle
    - b. **Lack of parallelism**—Distance between the friction surfaces is not even
    - c. **Inadequate thickness**—Distance between the friction surfaces is too small
    - d. **Grooving**—Shallow scratches in the surface of the rotor

      Note: Grooving is also referred to as scoring or gouging, if deep.
    - e. **Hard spotting**—Tempered areas of metal that become visible when the disc is machined or overheated; may appear as blue discoloration
    - f. **Heat checking**—Fine cracks in the surface of the rotor
    - g. **Cracking**—Separation of the metal of the rotor
    - h. **Taper**—Condition in which one or both sides of the rotor angle away from perpendicular to the axis
    - i. **Surface roughness**—Pits and deposits on the friction surface of the rotor

## Information Sheet

8. **Methods of assembling brake pads**

   a. **Bonding**—Use of glues or other adhesives to hold the lining to the pad

   b. **Riveting**—Use of rivets to hold the lining to the pad

9. **Brake pad defects**

   a. **Excessive wear**—Thickness of lining is less than manufacturer's recommendations

   b. **Unequal wear**—Condition in which the wear of the pad is uneven or the wear of the two pads is not equal

   c. **Tapered wear**—Condition in which the pad is worn at an angle from a high spot to a low spot, either side-to-side or end-to-end

   d. **Grooving**—Scratches, gouges, or scoring in the pad

   e. **Pad separation**—Condition of the lining coming off the pad or the material of the lining separating from itself

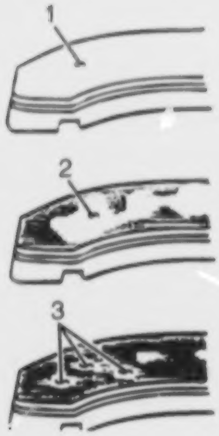
   f. **Pad contamination**—Oil, grease, or other substances have penetrated the lining

10. **Methods of determining wear on brake pads**

    a. **Audible signs**—Listen for squeal when metal tab on pad contacts the rotor

    b. **Visual signs**—Look for apparent wear and defects and measure thickness of pads

Figure 4



(1) Front brake pad with 100 percent contact area

(2) Front brake pad with 70 percent contact area (Good serviceable pad)

(3) Front brake pad with 20 percent contact area (Replacement is required)

Reprinted with permission of General Motors Corporation

## Information Sheet

11. **Functions of noise suppressants and hardware components of a brake pad**

    a. **Noise suppressants**—Reduce vibration and rattling of brake assembly components

    b. **Locator clips**—Position parts relative to each other where excessive pressures are not present

    c. **Antirattle clips**—Reduce vibration and rattling of parts

12. **Safety guidelines for disc brake service**

    a. Always follow manufacturer's procedures and specifications.

    b. Be sure to keep the parts correctly oriented and installed correctly.

    c. Perform all service operations on a clean bench, free from oil and other contaminants.

    d. Never allow a caliper to hang by the hydraulic brake line. This could lead to leaks and possible brake failure.

    e. Use care not to contaminate the linings with grease, oil, or hydraulic fluid. Replace any linings contaminated with these fluids.

    f. Avoid getting contaminants on the surface of the rotor. Clean off immediately if fluids are spilled onto it.

    g. Do not reuse old bushings, springs, cotter pins, and other small hardware parts. Always replace with new parts.

    h. Do not reuse brake system fluids.

    i. Do not mix power steering fluid with hydraulic brake fluid. Swelling and deterioration of rubber parts can result from fluid contamination, eventually leading to brake loss.

    j. Clean brake parts only with the cleaning solution recommended by the manufacturer.

    k. If a rotor must be resurfaced, resurface the other rotors on the same axle to try to maintain them at approximately the same thickness.

    l. Do not move the vehicle until a firm brake pedal is obtained. Failure to obtain a firm pedal before moving the vehicle could result in personal injury.

# Hydraulic Foundation Disc Brakes
## Unit 2-B

### Job Sheet 1—Remove, Clean, and Inspect a Caliper and Pad Assembly

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

| Evaluation Criteria | Rating |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Job ticket is filled out properly | ______ |
| Clean-up is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Jack and jack stands
6. Container for used brake fluid
7. C-clamp
8. Pry bar
9. Vehicle with hydraulic foundation disc brakes to be worked on
10. Others as recommended by instructor and equipment service manual

B. Procedure

Note: Refer to Job Sheet 1, Unit 1-A, if you need to move the vehicle into the shop.

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Apply the parking brake.

☐ 4. Block the vehicle wheels.

☐ 5. Remove about 2/3 of the brake fluid from the master cylinder.

☐ 6. Raise the vehicle and support with safety stands.

☐ 7. Remove tire and wheel assembly.

### Job Sheet 1

☐ 8. Pry caliper to one side.

☐ 9. Remove brake caliper retainer bolts.

☐ 10. Pull caliper assembly from rotor.

☐ 11. Use a C-clamp to compress the pistons. Watch for possible brake fluid overflow at the reservoir during this step.

**Caution: Do not let the front brake caliper hang from the brake hose.**

☐ 12. Remove brake pads from caliper.

☐ 13. Inspect caliper pistons for leaks.

Note: If leaks are found, the brake caliper will need overhauling. Refer to the brake caliper overhaul procedure in the service manual.

☐ 14. Inspect pads for wear and cracks.

☐ 15. Record findings on job ticket/work order.

☐ 16. Turn in job ticket when finished.

☐ 17. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ____________________

____________________

____________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| TOTAL PARTS/MATERIALS | | | |

## SPECIFICATIONS CHECKED

| | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |

School/Work Name ______________________

Address ______________________

Phone # ______________________

Date In ____________

Date Out ____________

## JOB TICKET

Customer Name ______________________

Customer Address ______________________

Customer Phone # ______________________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ______________________

Services/repairs made: ______________________

| LABOR | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

______________________ Date ____________

Technician ____________

Supervisor ____________

Unit 2-B, Job Ticket for Job Sheet 1

DT:B-B-33

## Hydraulic Foundation Disc Brakes
## Unit 2-B

### Job Sheet 2—Inspect, Measure, Remove, and Reinstall a Rotor Assembly

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

| **Evaluation Criteria** | **Rating** |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Specifications are checked | ______ |
| Adjustments are made | ______ |
| Job ticket is filled out properly | ______ |
| Clean-up is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Dial indicator gauge
5. Micrometer
6. Vehicle with hydraulic foundation disc brakes to be worked on
7. Others—as recommended by instructor and equipment service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Remove calipers. Refer to Job Sheet 1 or the service manual if assistance is needed.

☐ 4. Inspect and measure rotor on vehicle.

☐ 5. Check brake rotor lateral runout with dial indicator.

Note: Tighten the wheel bearings to zero end play.

☐ 6. Record findings on job ticket/work order.

☐ 7. Check service manual to see if dimensional specifications are okay.

## Job Sheet 2

☐ 8. Loosen wheel bearing nut and remove rotor hub assembly.

☐ 9. Clean rotor hub assembly and inspect.

☐ 10. Remove rotor from wheel hub.

Note: Hub and rotor may be made as one unit.

☐ 11. Clean and repack wheel bearings with grease. Refer to Job Sheet 1, Unit 2-A, or the service manual if assistance is needed.

☐ 12. Install new rotor back on hub.

☐ 13. Install new wheel bearing seal into hub. Refer to service manual for assistance.

☐ 14. Reinstall hub and rotor assembly back on axle.

☐ 15. Adjust wheel bearing. Refer to service manual for assistance.

☐ 16. Check to make sure hub rotates freely.

☐ 16. Turn in job ticket when finished.

☐ 17. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

______________________________

______________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE |
|---|---|---|
| | TOTAL PARTS/MATERIALS | |

### SPECIFICATIONS CHECKED

School/Work Name ______________________

Address ______________________

Phone # ______________________

Date In ______________________

Date Out ______________________

## JOB TICKET

Customer Name ______________________

Customer Address ______________________

Customer Phone # ______________________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ______________________

Services/repairs made: ______________________

**LABOR**

### Customer Authorization

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

______________________ Date ______________________

Technician ______________________

Supervisor ______________________

Unit 2-B, Job Ticket for Job Sheet 2

DT:B-B-37

# Hydraulic Foundation Disc Brakes
## Unit 2-B

### Job Sheet 3—Reinstall Caliper and Pad Assembly and Check Brake Operation

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

| Evaluation Criteria | Rating |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Specifications are checked | ______ |
| Adjustments/replacements are made | ______ |
| Job ticket is filled out properly | ______ |
| Clean-up is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Replacement brake fluid appropriate for system
5. C-clamp
6. Equipment to bleed hydraulic system
7. Replacement spring clips
8. Vehicle with hydraulic foundation disc brakes to be worked on
9. Others as recommended by instructor and equipment service manual

B. Procedure

Note: This job sheet is designed to follow Job Sheet 2. Those tasks must be completed prior to beginning this job sheet.

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Check to make sure pistons are pushed in the caliper bores. If not, use a C-clamp to push pistons in bore.

☐ 4. Install inner and outer brake pad on caliper.

☐ 5. Place caliper assembly on rotor.

## Job Sheet 3

☐ 6. Install new spring clips.

☐ 7. Adjust wheel speed sensor, if equipped.

☐ 8. Install retainer bolts.

☐ 9. Install brake fluid into the master cylinder reservoir.

☐ 10. Bleed the hydraulic brake system. Refer to service manual for instructions.

☐ 11. Pump the brake pedal several times to make sure it is firm and the pads are adjusted.

☐ 12. Check brake fluid in master cylinder.

☐ 13. Install tires and wheels.

☐ 14. Lower the vehicle.

☐ 15. Remove the wheel blocks.

**Caution: Do not move the vehicle until a firm brake pedal is obtained.**

☐ 16. Turn in job ticket when finished.

☐ 17. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

______________________________

______________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE |
|---|---|---|
| | | |
| TOTAL PARTS/MATERIALS | | |

**SPECIFICATIONS CHECKED**

School/Work Name ____________

Address ____________

Phone # ____________

Date In ____________

Date Out ____________

## JOB TICKET

Customer Name ____________

Customer Address ____________

Customer Phone # ____________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ____________

Services/repairs made: ____________

**LABOR**

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

____________ Date ____________

Technician ____________

Supervisor ____________

Unit 2-B, Job Ticket for Job Sheet 3

DT:B-B-41

# Hydraulic System
# Unit 3-B

## Objective Sheet

### Unit Objective

After completing this unit, the student should be able to perform routine service of hydraulic systems. The student should demonstrate these competencies by completing the assignment sheets and job sheets and by scoring a minimum of 85 percent on the written test.

### Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to the hydraulic system with their definitions.
2. Label the components of a hydraulic system.
3. Match the components of a hydraulic system with their functions.
4. Identify the parts of a brake pedal.
5. Identify the parts of a combination brake valve.
6. Match the parts of a combination brake valve with their functions.
7. Match brake valve defects with their descriptions.
8. Match methods of bleeding the hydraulic system with their descriptions.
9. Identify the parts of a master cylinder.
10. Distinguish between the types of wheel cylinders.
11. Distinguish between the types of brake lines.
12. Identify the types of brake line connections.
13. Distinguish between the types of parking brakes.
14. Describe switch operation for brake lights and brake failure warning lights.
15. Interpret hydraulic system diagrams. (Assignment Sheet 1)
16. Interpret brake light system circuit diagrams. (Assignment Sheet 2)
17. Test hydraulic system and inspect for leaks; determine needed repairs. (Job Sheet 1)
18. Bleed and/or flush the hydraulic brake system. (Job Sheet 2)
19. Remove, inspect, and repair or replace the hydraulic brake valve. (Job Sheet 3)
20. Remove, inspect, and repair or replace the master cylinder. (Job Sheet 4)

## Objective Sheet

21. Create flare and double flare fittings. (Job Sheet 5)
22. Remove and repair or replace the wheel cylinder. (Job Sheet 6)
23. Check and adjust the parking brake. (Job Sheet 7)
24. Check operation of brake light switch; adjust or replace as needed. (Job Sheet 8)

# Hydraulic System
## Unit 3-B

### Information Sheet

1. **Terms and definitions**

   a. **Bleeding**—Process of removing air from the hydraulic brake system

   b. **Flare**—To spread the end of a metal tube so that a connector can be installed

   c. **Flushing**—Process of removing the fluid in a hydraulic brake system in order to remove contaminants in the fluid

   d. **Hydraulic**—Pertaining to a system in which force is transmitted by means of a liquid

   e. **Kink**—Bend in tubing in which the inside diameter of the tubing does not remain uniformly curved

   f. **Metering**—Process of controlling the rate of flow of a substance through holes

   g. **Reservoir**—Section of an assembly designed to store a liquid

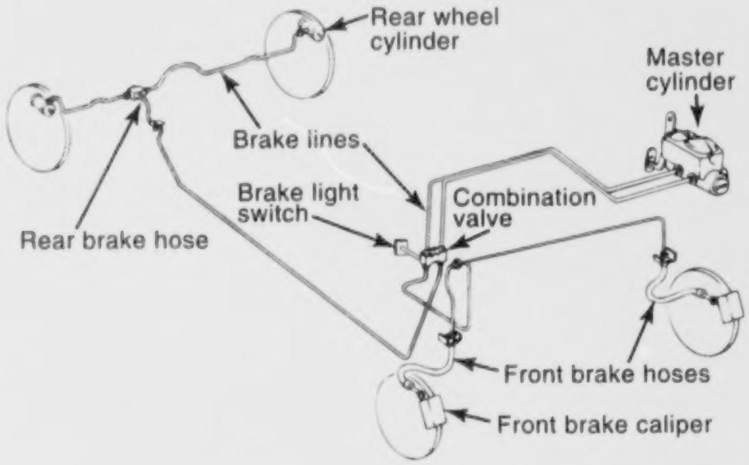
   h. **Split**—Divided, usually into two halves

   Note: Many brake systems are split as a safety feature so that if there is a leak in one part of the system, the other half is not affected.

   i. **Valve**—Device used to meter or proportion the fluid pressure or flow in a hydraulic system

2. **Components of a hydraulic system**

Figure 1


Rear wheel cylinder
Master cylinder
Brake lines
Brake light switch
Combination valve
Rear brake hose
Front brake hoses
Front brake caliper

## Information Sheet

### 3. Functions of hydraulic system components

a. **Brake pedal**—Transfers force from the vehicle operator to the brake hydraulic system

b. **Master cylinder**—Stores brake fluid and transfers force from the brake pedal to the wheel cylinders

c. **Brake hoses and lines**—Route brake fluid between master cylinder and wheel cylinders

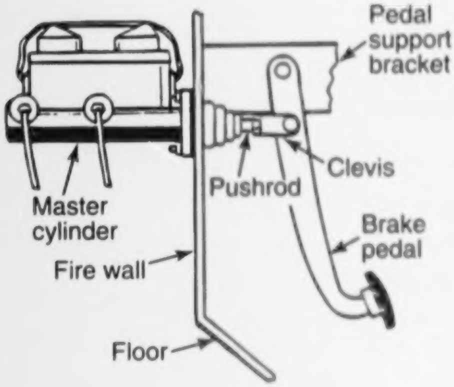
d. **Combination brake valve**—Meters and proportions fluid pressure through the system

e. **Wheel cylinder**—Transfers the force of the brake pedal to engage the brakes against the braking surface

f. **Brake light switch**—Turns brake lights on as operator applies brake

### 4. Parts of a brake pedal

Figure 2

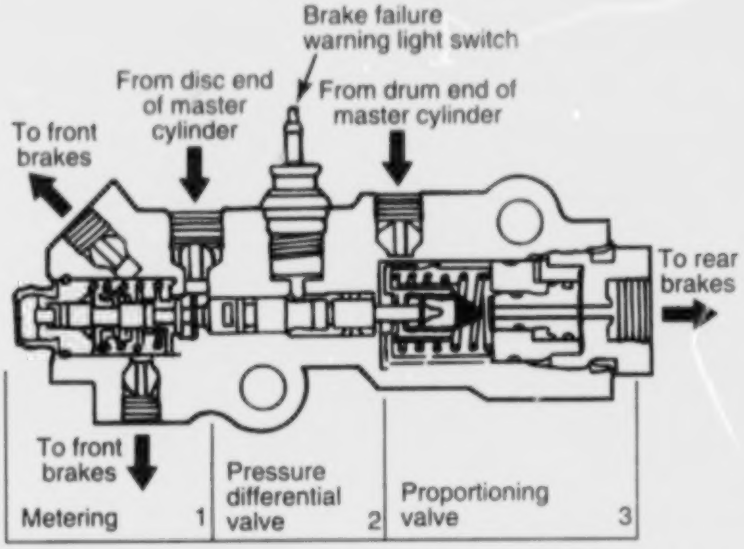

Pedal support bracket
Clevis
Pushrod
Master cylinder
Brake pedal
Fire wall
Floor

Courtesy of RDT

Information Sheet

5. **Parts of a combination brake valve**

Figure 3


Brake failure warning light switch
From disc end of master cylinder
From drum end of master cylinder
To front brakes
To rear brakes
To front brakes
Metering 1
Pressure differential valve 2
Proportioning valve 3

From *Automotive Brake Service, Unit 3:* Rear Drum Brake and Hydraulic System Service © 1981 by State of Florida, Department of State. Used with permission of State of Florida, Department of State.

6. **Functions of a combination brake valve**

   a. **Metering valve**—Ensures that the front and rear brakes are applied at the same time

   b. **Pressure differential valve**—Monitors for differences in system hydraulic pressure as an indication of brake failure

   c. **Proportioning valve**—Reduces pressure to the rear wheels during hard braking

7. **Brake valve defects and their descriptions**

   a. **External leak**—Brake fluid leaks from the valve through cracks in the housing, loose or defective fittings, or bad seals

   b. **Internal leak**—Brake fluid leaks past pistons and seals so that valve does not hold pressure

   c. **Frozen parts**—Parts that do not move as required due to corrosion, misalignment from wear, or deformity from overheating

   d. **Broken or worn springs**—Malfunctions that result from springs that do not provide adequate pressure or that are broken, misaligned, or deformed

   e. **Contamination of fluid**—Poor hydraulic response due to air, water, or other contaminants in the brake fluid

## Information Sheet

8. **Methods of bleeding the hydraulic system**

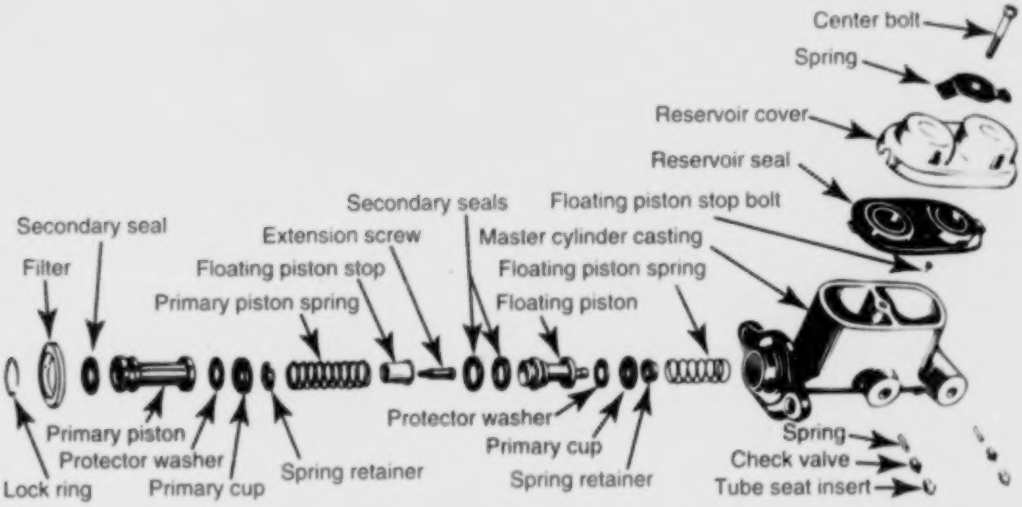
   a. **Manual bleeding**—Brake fluid is added to part of the brake system and drained from it until there is no longer evidence of air in the form of bubbles in the fluid

   b. **Bench bleeding**—Bleeding of a single component of the brake system while it is removed from the system

   c. **Pressure bleeding**—Use of a device that provides brake fluid under pressure so that the system can be bled without operating the system components

9. **Parts of a master cylinder (dual type shown)**

Figure 4


Center bolt
Spring
Reservoir cover
Reservoir seal
Secondary seals
Floating piston stop bolt
Secondary seal
Extension screw
Master cylinder casting
Filter
Floating piston stop
Floating piston spring
Primary piston spring
Floating piston
Primary piston
Protector washer
Protector washer
Primary cup
Spring
Check valve
Tube seat insert
Lock ring
Primary cup
Spring retainer
Spring retainer

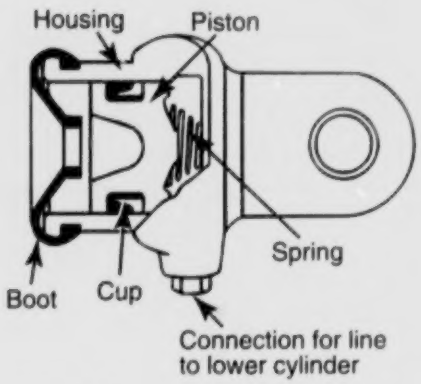
Courtesy of Haldex Midland Services

## Information Sheet

### 10. Types of wheel cylinders

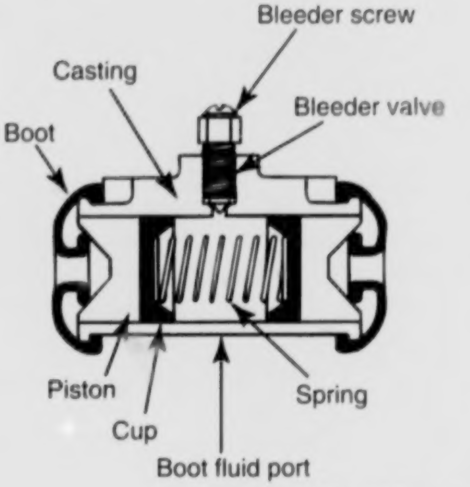
a. Single piston

Figure 5


Housing
Piston
Spring
Boot
Cup
Connection for line to lower cylinder

b. Double piston

Figure 6


Bleeder screw
Casting
Bleeder valve
Boot
Piston
Spring
Cup
Boot fluid port

Courtesy of Haldex Midland Services

### 11. Types of brake lines

a. **Steel tubing**

1) Hollow brake line made of bendable steel that has been coated to reduce rust and corrosion

2) Lengths can be adjusted as needed with tubing cutter and flaring tools.

b. **Hoses**

1) Hollow brake line made of alternating layers of flexible rubber and fabric with threaded metal fittings at each end

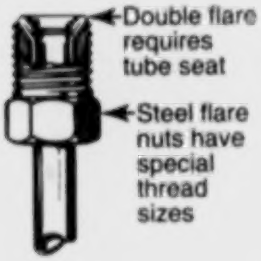
2) Must be purchased from the original equipment manufacturer (OEM) at specified lengths; ends are not replaceable.

## 12. Types of brake line connections

a. For steel tubing

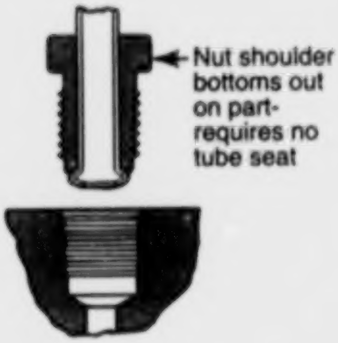
1) Double flare fitting

Figure 7


Double flare requires tube seat
Steel flare nuts have special thread sizes

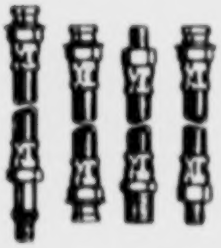
2) ISO flare fitting

Figure 8


Nut shoulder bottoms out on part-requires no tube seat

b. For hose end fittings

Figure 9



Courtesy of Federal-Mogul Corporation

## 13. Types of parking brakes

a. **Manual**—Driveline or rear transmission operated by lever and cable

b. **Hydraulic**—Uses hydraulic pressure to release mechanical spring brake or wedge type spring brake that is hydraulically released

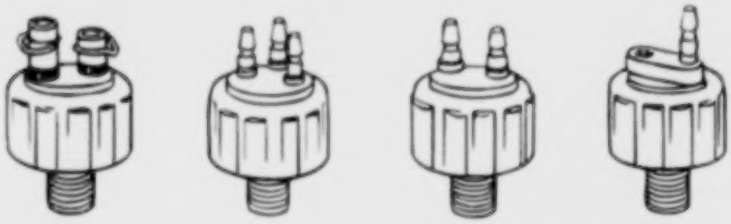
## Information Sheet

### 14. Switch operation for brake lights and brake failure warning lights

a. **Brake light switches**

1) **Hydraulic switch systems**

Figure 10



Courtesy of AlliedSignal Bendix

a) Movement of the hydraulic fluid in the master cylinder bore expands a diaphragm in the switch.

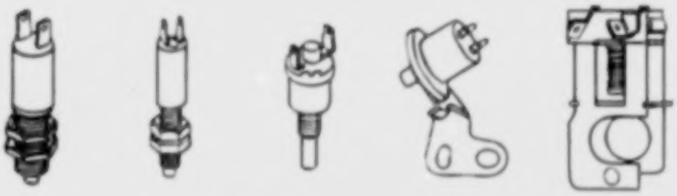
b) The diaphragm closes the contacts inside the switch to complete the circuit.

c) With the circuit complete, electricity from the battery flows to the brake lights and illuminates them.

d) When the brakes are released, the pressure on the diaphragm is removed and the contacts open.

2) **Mechanical switch systems**

Figure 11



Courtesy of AlliedSignal Bendix

a) Movement of the brake pedal depresses a spring-loaded switch in the switch unit.

b) The switch closes the contacts inside the switch assembly to complete the circuit.

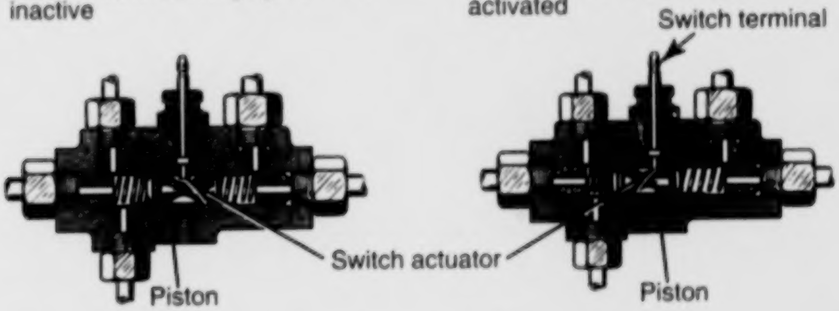
c) With the circuit complete, electricity from the battery flows to the brake lights and illuminates them.

## Information Sheet

d) When the brake pedal is released, the spring returns the switch to the open position.

b. **Brake failure warning light switches**—Used to indicate a brake system failure

Figure 12



Brake valve in normal position-Brake failure warning light switch inactive

Brake valve in failed position-Brake failure warning light switch activated

Equal pressure in both front and rear hydraulic systems

Pressure in the front hydraulic system is low, allowing the higher pressure in the rear system to move the switch piston to turn on the brake failure warning light.

1) When the brakes are applied, hydraulic fluid is forced through the system, including the pressure differential valve.

2) The fluid is split between two of the halves of the system with fluid flowing on each side of the pressure differential valve.

3) If the pressure is greater on one side than on the other, the piston between the two fluid passages will cause the piston to shift away from the higher pressure.

4) The shifting of the piston pushes a switch which closes a contact in the warning light circuit.

5) When the pressure is equalized, the piston may or may not return to its centered position, depending on the design of the valve.

# Hydraulic System
## Unit 3-B

### Assignment Sheet 1—Interpret Hydraulic System Diagrams

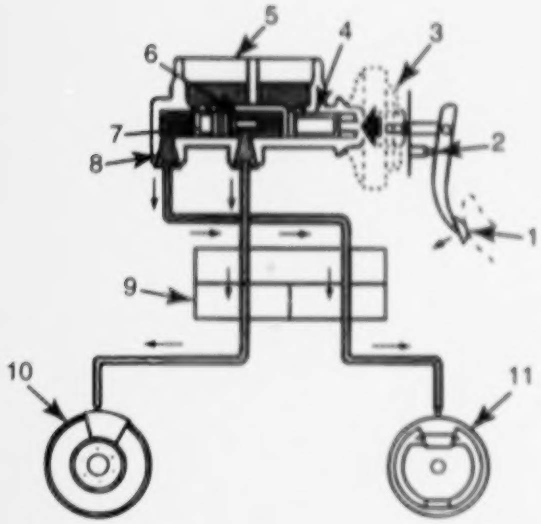
Name ______________________ Overall Rating ____________

| Evaluation Criteria | Rating |
|---|---|
| Directions are followed | ______ |
| Questions are answered correctly | ______ |

Directions: Study the illustrations below and on the following pages. Use the information provided in the illustrations to answer the questions accompanying each diagram. Write your answers in the spaces provided.

1. Figure 1 shows a typical hydraulic circuit. Major components in the circuit are labeled with arrows and numbers. A legend accompanies the diagram to explain the numbered parts.

Figure 1



1. Brake pedal
2. Brake light switch
3. Booster (if used)
4. Pushrod
5. Master cylinder
6. Primary piston
7. Secondary piston
8. Secondary line
9. Combination valve
10. Front wheel
11. Rear wheel

Illustration used with permission of Ford Motor Company

a. Are the rear wheels equipped with disc or drum brakes?

______________________________________________

b. Are the front wheels served by the primary or secondary circuit?

______________________________________________

## Assignment Sheet 1

c. Is the brake light switch shown mechanically or hydraulically operated?

______________________________

d. What part of the system is designated by the number 4?

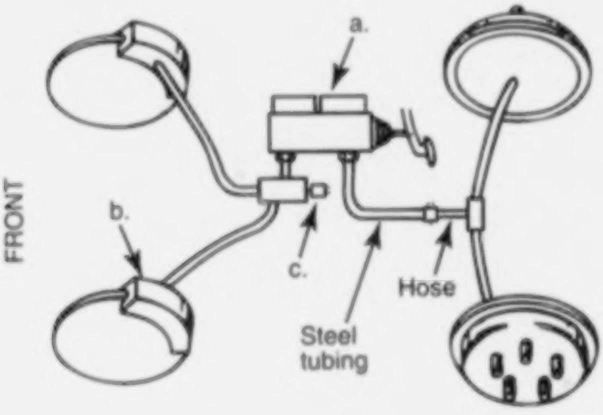
______________________________

e. The primary and secondary circuit lines cross above the combination valve in the diagram. Does that mean that they are joined at that point in the system?

______________________________

2. Figure 2 shows a brake system diagram. None of the parts are labeled.

Figure 2



Chilton®

"Chilton is a registered trademark of Cahners Business Information, A Division of Reed Elsevier Inc. and has been licensed to W.G. Nichols, Inc."

a. Which of the following is a correct description of how the system is split? Write an "X" beside the correct answer.

______ 1) Front wheels together, and rear wheels together

______ 2) Right front and left rear wheels together

______ 3) Left front and right rear wheels together

______ 4) None of the above because the system is not split

b. Is the brake light switch shown as part "c" mechanically or hydraulically operated?

______________________________

c. What is the part identified as "a"? ______________________________

d. What is the part identified as "b"? ______________________________

## Assignment Sheet 1

e. At the rear axle, why does the hydraulic line change from steel tubing to hose? Explain.

______________________________________________

______________________________________________

# Hydraulic System
# Unit 3-B

## Assignment Sheet 2—Interpret Brake Light System Circuit Diagrams

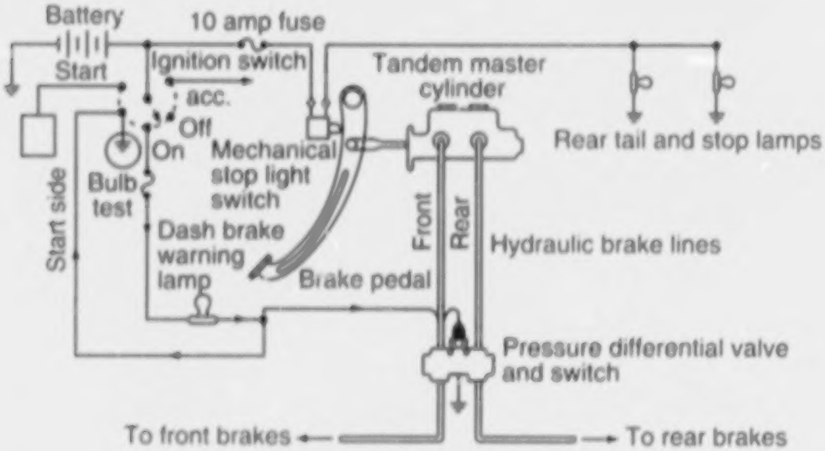
Name ______________________________ Overall Rating ____________

| Evaluation Criteria | Rating |
|---|---|
| Directions are followed | ______ |
| Questions are answered correctly | ______ |

Directions: Study the illustrations below and on the following pages. Use the illustrations to answer the questions that accompany the diagrams. Write your answers in the spaces provided.

1. Figure 1 shows the electrical circuits used with a dual hydraulic brake system.

Figure 1


Battery
10 amp fuse
Start
Ignition switch
acc.
Off
On
Bulb test
Start side
Mechanical stop light switch
Tandem master cylinder
Rear tail and stop lamps
Dash brake warning lamp
Brake pedal
Front
Rear
Hydraulic brake lines
Pressure differential valve and switch
To front brakes
To rear brakes

Courtesy of Federal-Mogul Corporation

a. Does the system use a mechanical or hydraulic stop light switch?

______________________________________________

b. What amperage of fuse is used between the stop light switch and the battery?

______________________________________________

c. If the brake pedal is depressed and the brakes fail while the ignition switch is in the off position, will the dash brake warning light illuminate?

______________________________________________

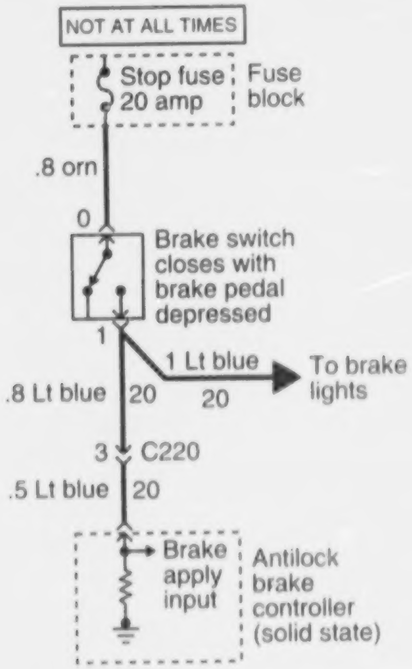
## Assignment Sheet 2

d. If the brake pedal is depressed while the ignition switch is off, will the rear stop lamps illuminate?

e. One symbol is shown in several places on the diagram—to the left of the battery, by the stop lamps, and beneath the pressure differential valve and switch. The symbol looks like three short lines, each smaller than the one above it. What does this symbol represent?

2. Figure 2 shows a portion of a brake system electrical diagram. Three components are shown: the brake pedal switch, the antilock brake controller, and the fuse for the brake electrical circuit.

Figure 2


NOT AT ALL TIMES
Stop fuse
20 amp
Fuse block
.8 orn
0
Brake switch closes with brake pedal depressed
1
1 Lt blue
To brake lights
.8 Lt blue
20
20
3
C220
.5 Lt blue
20
Brake apply input
Antilock brake controller (solid state)

Courtesy of Navistar International Transportation Corp.

a. The brake switch is shown in the open position. What causes the switch to close?

b. What color of wire connects the brake switch to the brake lights?

c. What amperage of fuse is used in this circuit?

## Assignment Sheet 2

d. What color of wire connects the fuse block to the brake switch?

____________________________________________

e. What is the reference number for the terminal on the antilock brake controller?

____________________________________________

# Hydraulic System
# Unit 3-B

## Job Sheet 1—Test Hydraulic System and Inspect for Leaks; Determine Needed Repairs.

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

| Evaluation Criteria | Rating |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Job ticket is filled out properly | ______ |
| Cleanup is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Vehicle with hydraulic brake system to be worked on
6. Others—as recommended by instructor and equipment service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Move vehicle into shop.

☐ 4. Block wheels.

☐ 5. Check the master cylinder fluid level. A slightly low brake fluid level in either reservoir is normal; very low is not normal.

☐ 6. With the engine at idle and the transmission in NEUTRAL, apply and hold constant foot pressure on the brake pedal. If the pedal gradually falls away, the brake hydraulic system may have external or internal leakage.

☐ 7. Perform visual inspection of the hydraulic system to check for external leaks.

☐ 8. Check all brake hoses and fittings for breaks, cracks, or other damage.

## Job Sheet 1

☐ 9. If no external leaks are found, internal leakage may be the cause. Refer to the brake system diagnostic chart in the service manual for instructions to check for internal leaks.

☐ 10. Record findings on job ticket/work order.

☐ 11. Turn in job ticket when finished.

☐ 12. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________________________

____________________________________________________________

____________________________________________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE |
|---|---|---|
| | | |
| | TOTAL PARTS/MATERIALS | |

**SPECIFICATIONS CHECKED**

School/Work Name ____________________

Address ____________________

Phone # ____________________

Date In ____________

Date Out ____________

## JOB TICKET

Customer Name ____________________

Customer Address ____________________

Customer Phone # ____________________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ____________________

Services/repairs made: ____________________

**LABOR**

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

____________________ Date ____________

Technician ____________

Supervisor ____________

Unit 3-B, Job Ticket for Job Sheet 1

DT:B-B-63

# Hydraulic System
## Unit 3-B

### Job Sheet 2—Bleed and/or Flush the Hydraulic Brake System

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

| Evaluation Criteria | Rating |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Specifications are checked | ______ |
| Job ticket is filled out properly | ______ |
| Cleanup is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Jack and jack stands
6. Brake bleeder kit or other approved equipment to bleed hydraulic system
7. Replacement brake fluid appropriate for system
8. Vehicle with hydraulic brake system to be worked on
9. Others—as recommended by instructor and equipment service manual

B. Guidelines

1. Be careful not to spill hydraulic brake fluid on your skin or splash it in your eyes.

2. Be careful not to spill hydraulic brake fluid on any painted surfaces of the vehicle or electrical connections. Clean up any spills on the floor immediately.

C. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Move vehicle into shop.

☐ 4. Block wheels.

☐ 5. Raise vehicle and install safety stands.

## Job Sheet 2

☐ 6. Check service manual for correct brake fluid type.

☐ 7. Connect brake bleeder kit to master cylinder.

☐ 8. Flush the brake hydraulic system by opening the bleeder valves at the calipers and/or wheel cylinders.

☐ 9. Add new brake fluid and run through the system until it comes out clear in color.

☐ 10. Bleed until all air is removed from system.

☐ 11. When bleeding, the warning lamps may come on. Refer to service manual for procedure to reset.

☐ 12. Lower the vehicle safely.

☐ 13. Check to make sure there is a firm brake pedal **before** moving the vehicle.

☐ 14. Turn in job ticket when finished.

☐ 15. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ____________________

____________________

____________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| TOTAL PARTS/MATERIALS | | | |

## SPECIFICATIONS CHECKED

| | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |

School/Work Name ____________________

Address ____________________

Phone # ____________________

Date In ____________

Date Out ____________

## JOB TICKET

Customer Name ____________________

Customer Address ____________________

Customer Phone # ____________________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ____________________

____________________

Services/repairs made: ____________________

| | LABOR | |
|---|---|---|
| ____________________ | | |
| ____________________ | | |
| ____________________ | | |
| ____________________ | | |
| ____________________ | | |
| ____________________ | | |
| ____________________ | | |
| ____________________ | | |
| ____________________ | | |
| ____________________ | | |
| ____________________ | | |

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

____________________ Date ____________

Technician ____________

Supervisor ____________

Unit 3-B, Job Ticket for Job Sheet 2

DT:B-B-67

# Hydraulic System
# Unit 3-B

## Job Sheet 3—Remove, Inspect, and Repair or Replace the Hydraulic Brake Valve

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

| Evaluation Criteria | Rating |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Specifications are checked | ______ |
| Repair/replacements are made correctly | ______ |
| Job ticket is filled out properly | ______ |
| Cleanup is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Hydraulic floor jack
6. Jack stands
7. Drain pan
8. Hydraulic brake system to be worked on
9. Others as recommended by instructor and equipment service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Block wheels.

☐ 4. Inspect the brake valve(s) for leaks and operation. These may be separate valves or one combination valve.

☐ 5. Clean all dirt, grease, and other foreign material from the valve.

☐ 6. Remove hydraulic pipes from brake valve(s). Plug the pipes to prevent fluid loss.

☐ 7. Disconnect warning switch connector.

## Job Sheet 3

☐ 8. Remove bolts and washers.

☐ 9. Remove brake valve(s).

☐ 10. Check with your instructor whether or not you should repair the brake valve or replace it with a new valve.

☐ 11. Install brake valve and torque bolts to manufacturer's specifications.

☐ 12. Connect the warning switch connector.

☐ 13. Bleed system. (Refer to previous job sheet.)

☐ 14. Check brake pedal for "sponginess" and the brake warning lamp for indication of unbalanced pressure.

☐ 15. Check brake pedal for correct travel before moving the vehicle.

☐ 16. Record all findings on job ticket.

☐ 17. Turn in job ticket when finished.

☐ 18. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ____________________

____________________

____________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| TOTAL PARTS/MATERIALS | | |

**SPECIFICATIONS CHECKED**

School/Work Name ____________

Address ____________

Phone # ____________

Date In ____________

Date Out ____________

## JOB TICKET

Customer Name ____________

Customer Address ____________

Customer Phone # ____________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ____________

Services/repairs made: ____________

**LABOR**

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

____________ Date ____________

Technician ____________

Supervisor ____________

Unit 3-B, Job Ticket for Job Sheet 3

DT:B-B-71

# Hydraulic System
## Unit 3-B

### Job Sheet 4—Remove, Inspect, and Repair or Replace the Master Cylinder

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

| Evaluation Criteria | Rating |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Specifications are checked | ______ |
| Job ticket is filled out properly | ______ |
| Cleanup is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Container for used brake fluid
6. Replacement brake fluid appropriate for system
7. Hot soapy water
8. Brake cylinder hone
9. Snap ring plier set
10. Vehicle with hydraulic brake system to be worked on
11. Others—as recommended by instructor and equipment service manual

B. Guidelines

1. Be careful not to spill hydraulic brake fluid on your skin or splash it in your eyes.

2. Be careful not to spill hydraulic brake fluid on any painted surfaces of the vehicle or electrical connections. Clean up any spills on the floor immediately.

C. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Move vehicle into shop.

☐ 4. Block wheels.

## Job Sheet 4

☐ 5. Place a suitable container under master cylinder to catch fluid.

☐ 6. Remove brake fluid from master cylinder.

☐ 7. Disconnect hydraulic pipes from master cylinder. Place a suitable container under master cylinder to catch fluid.

☐ 8. Cap or plug the pipes.

☐ 9. If equipped, disconnect low fluid level sensor connector.

☐ 10. Remove mounting nuts.

☐ 11. Remove master cylinder.

☐ 12. Check and inspect for cracks in the casing or brake fluid leaks.

☐ 13. Disassemble master cylinder.

☐ 14. Check condition of cylinder bore.

☐ 15. Check with instructor to see if master cylinder should be replaced with new one or overhauled.

☐ 16. Clean with only hot soapy water.

☐ 17. Hone cylinder bore.

☐ 18. Install new master cylinder kit.

☐ 19. Bench bleed master cylinder to remove air from that component.

  ☐ a. Place master cylinder into vise.

  ☐ b. Fill the reservoir with clean brake fluid. Check service manual for correct brake fluid.

  ☐ c. Follow procedure in your service manual for bench bleeding.

☐ 20. Install master cylinder back on vehicle.

☐ 21. Check and adjust brake pedal pushrod length. Adjust if necessary.

☐ 22. Bleed the brake system. Refer to Job Sheet 2, Unit 3-B, or service manual if assistance is needed.

☐ 23. Turn in job ticket when finished.

## Job Sheet 4

☐ 24. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ____________________________________________

____________________________________________

____________________________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE | |
|---|---|---|---|
| | | | |
| TOTAL PARTS/MATERIALS | | | |

## SPECIFICATIONS CHECKED

| | |
|---|---|
| | |

School/Work Name ____________________

Address ____________________

Phone # ____________________

Date In ____________

Date Out ____________

## JOB TICKET

Customer Name ____________________

Customer Address ____________________

Customer Phone # ____________________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ____________________

Services/repairs made: ____________________

| LABOR | |
|---|---|
| | |

### Customer Authorization

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

____________________ Date ____________

Technician ____________

Supervisor ____________

Unit 3-B, Job Ticket for Job Sheet 4

DT:B-B-77

# Hydraulic System
# Unit 3-B

## Job Sheet 5—Create Flare and Double Flare Fittings

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

| **Evaluation Criteria** | **Rating** |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual or instructions are used properly | ______ |
| Parts are inspected accurately | ______ |
| Repairs are made | ______ |
| Job ticket is filled out properly | ______ |
| Cleanup is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Tubing tool set
5. Instructions for tubing tool set
6. Steel brake tubing
7. Flare nuts
8. Vise
9. Others—as recommended by instructor and equipment service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual or follow the instructions with the tubing tool set.

Note: Most tubing tool sets work the same, but check to make sure, even if you have done this before.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Loosen the two wing nuts on the flaring bar. This permits separation of the two halves of the tool.

☐ 4. Slide flare nut onto tubing.

☐ 5. Before inserting tubing in flaring bar, be sure end of tubing to be flared has been cut off squarely and burr removed from inside edge.

## Job Sheet 5

☐ 6. Insert the tubing into the flaring bar hole of proper size, with end of tubing protruding above top of flaring bar by a distance equal to the width of shoulder on adapter of corresponding size.

☐ 7. Tighten wing nuts. It is good practice to tighten the wing nut nearest to the tube first and then tighten the other one. Nuts must be securely tightened so there is no chance of the tube slipping.

☐ 8. Place yoke over bar of tool.

☐ 9. Place adapter of proper size on the protruding end of tubing, with pilot or stem of adapter inserted into tubing.

☐ 10. Move yoke into position so that flaring cone centers directly over the adapter.

☐ 11. Screw cone down until cone and adapter engage. Make sure adapter is centered in the tubing and continue to tighten until shoulder of adapter rests on flaring bar.

☐ 12. Back off flaring cone slightly, remove adapter, and screw cone down again tightly. This folds the tubing back on itself.

☐ 13. Check surface of flare to make sure it is even.

☐ 14. Turn in job ticket when finished.

☐ 15. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

______________________________

______________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | TOTAL PARTS/MATERIALS | | |

## SPECIFICATIONS CHECKED

| | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |

School/Work Name ______________________

Address ______________________

Phone # ______________________

Date In ____________

Date Out ____________

## JOB TICKET

Customer Name ______________________

Customer Address ______________________

Customer Phone # ______________________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ______________________

Services/repairs made: ______________________

| LABOR | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

______________________ Date ____________

Technician ____________

Supervisor ____________

Unit 3-B, Job Ticket for Job Sheet 5

DT:B-B-81

# Hydraulic System
# Unit 3-B

## Job Sheet 6—Remove and Repair or Replace the Wheel Cylinder

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

| **Evaluation Criteria** | **Rating** |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Specifications are checked | ______ |
| Adjustments/replacements/repairs are made | ______ |
| Job ticket is filled out properly | ______ |
| Cleanup is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Container for used brake fluid
6. Replacement brake fluid appropriate for system
7. Brake cylinder hone or crocus cloth
8. Hot soapy water
9. Vehicle with hydraulic brake system to be worked on
10. Others—as recommended by instructor and equipment service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Move vehicle into shop.

☐ 4. Block wheels.

☐ 5. Remove brake drums and brake shoes. Refer to Job Sheet 1, Unit 1-B, and Job Sheet 2, Unit 1-B, or the service manual if assistance is needed.

☐ 6. Disconnect brake line that connects to wheel cylinder.

☐ 7. Remove wheel cylinder hold-down bolts.

**Job Sheet 6**

☐ 8. Remove wheel cylinder from backing plate.

☐ 9. Plug brake line to keep fluid from leaking out.

☐ 10. Place wheel cylinder on work bench.

☐ 11. Remove bleeder valve.

☐ 12. Remove boots, pistons, and seals. Spring assembly can also be removed.

☐ 13. Inspect cylinder bore for scoring and corrosion.

☐ 14. Inspect spring assembly for signs of discoloration due to heat.

☐ 15. Replace if necessary.

☐ 16. Clean the inside of the cylinder bore with a hone or crocus cloth.

☐ 17. Wash with hot soapy water, and then clean with clean brake fluid.

☐ 18. Lubricate the new seals and cylinder bore with clean brake fluid.

☐ 19. Install spring assembly.

☐ 20. Install seals and pistons.

☐ 21. Connect boots back on cylinder.

☐ 22. Install bleeder valve.

☐ 23. Install wheel cylinder assembly on backing plate.

☐ 24. Bleed brake system after brake drums have been installed. Refer to Job Sheet 2, Unit 3-B, or the service manual if assistance is needed.

☐ 25. Turn in job ticket when finished.

☐ 26. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

______________________________

______________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | TOTAL PARTS/MATERIALS | |

**SPECIFICATIONS CHECKED**

| | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |

School/Work Name ______

Address ______

Phone # ______

Date In ______

Date Out ______

## JOB TICKET

Customer Name ______

Customer Address ______

Customer Phone # ______

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ______

Services/repairs made: ______

| LABOR | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

______ Date ______

Technician ______

Supervisor ______

Unit 3-B, Job Ticket for Job Sheet 6

DT:B-B-85

# Hydraulic System
# Unit 3-B

## Job Sheet 7—Check and Adjust the Parking Brake

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

| Evaluation Criteria | Rating |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Specifications are checked | ______ |
| Repair/replacements are made correctly | ______ |
| Job ticket is filled out properly | ______ |
| Cleanup is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Hydraulic floor jack
6. Jack stands
7. Hydraulic brake system to be worked on
8. Others—as recommended by instructor and equipment service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Block wheels.

☐ 4. Place the hand lever in the "off" position.

☐ 5. Rotate the knurled knob on the hand lever counterclockwise to the end of its travel.

☐ 6. Make lining wear and linkage adjustments as needed. The vehicle may have to be raised in order to make adjustments.

☐ 7. Place the hand lever in the "on" position.

## Job Sheet 7

☐ 8. Rotate the knurled knob clockwise to adjust the lever operating effort.

☐ 9. Check the parking brake operating and holding ability.

☐ 10. Turn in job ticket when finished.

☐ 11. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

______________________________

______________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE |
|---|---|---|
| | | |
| TOTAL PARTS/MATERIALS | | |

**SPECIFICATIONS CHECKED**

School/Work Name ____________________
Address ____________________
Phone # ____________________

Date In ____________
Date Out ____________

## JOB TICKET

Customer Name ____________________
Customer Address ____________________
Customer Phone # ____________________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ____________________

Services/repairs made: ____________________

**LABOR**

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

____________________ Date ____________

Technician ____________
Supervisor ____________

Unit 3-B, Job Ticket for Job Sheet 7

DT:B-B-89

DT:B-B-91

## Hydraulic System
## Unit 3-B

### Job Sheet 8—Check Operation of Brake Light Switch; Adjust or Replace as Needed

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

| Evaluation Criteria | Rating |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Specifications are checked | ______ |
| Adjustments/replacements/repairs are made | ______ |
| Job ticket is filled out properly | ______ |
| Cleanup is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Vehicle with hydraulic brake system to be worked on
6. Others—as recommended by instructdr and equipment service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Move vehicle into the shop.

☐ 4. Block wheels.

☐ 5. Locate brake light switch.

☐ 6. With the shop door closed, push on brake pedal and check light operation.

☐ 7. Apply the brake pedal as far as possible to adjust switch.

☐ 8. While applying the brake pedal, pull the switch adjustment arm rearward to a stop.

## Job Sheet 8

☐ 9. Release the brake pedal.

☐ 10. On a hydraulically-operated switch, you will need to replace it if it does not operate correctly.

☐ 11. Record findings on job ticket/work order.

☐ 12. Turn in job ticket when finished.

☐ 13. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| TOTAL PARTS/MATERIALS | | | |

## SPECIFICATIONS CHECKED

| | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |

School/Work Name ______________________

Address ______________________

Phone # ______________________

Date In ______________

Date Out ______________

## JOB TICKET

Customer Name ______________________

Customer Address ______________________

Customer Phone # ______________________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ______________________

Services/repairs made: ______________________

| LABOR | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

______________________ Date ______________

Technician ______________

Supervisor ______________

Unit 3-B, Job Ticket for Job Sheet 8

DT:B-B-93

# Power Assist Units and Related Components
# Unit 4-B

## Objective Sheet

**Unit Objective**

After completing this unit, the student should be able to remove, inspect, test, and repair or replace power assist units and related components. The student should demonstrate these competencies by completing the job sheets and by scoring a minimum of 85 percent on the written test.

**Specific Objectives**

After completing this unit, the student should be able to:

1. Match terms related to power assist units and related components with their definitions.
2. State the purpose of a power assist unit.
3. Distinguish between the basic types of power assist units.
4. Identify the parts of a vacuum power assist unit.
5. Identify the parts of a hydraulic power assist unit and related components.
6. Match the basic parts of power assist units with their functions.
7. Describe the most common problems associated with power assist units.
8. Complete statements concerning the adjustment of the brake booster push rod.
9. Distinguish between the emergency back-up systems.
10. Complete statements concerning the use of brake fluid and power steering fluid on power assist units.
11. Inspect and test the power assist system and emergency brake back-up system; determine needed repairs. (Job Sheet 1)
12. Remove, inspect, and repair or replace the power assist unit. (Job Sheet 2)
13. Check operation of brake failure lights and braking warning devices; repair or replace as needed. (Job Sheet 3)

# Power Assist Units and Related Components
## Unit 4-B

### Information Sheet

1. **Terms and definitions**

   a. **Accumulator**—Device used to store power

   b. **Brake fluid**—Glycol-based substance used to transmit force in hydraulic brake systems

   c. **Diaphragm**—Thin, flexible membrane used to separate two areas; flexes in response to changes in air pressure on each side of it

   d. **Differential**—Difference in air pressure from one side to another

   e. **Hydraulic oil**—Petroleum-based substance used in hydraulic pumps

   Note: Hydraulic oil includes power steering fluid and automatic transmission fluid. These fluids are often grouped together and may be called hydraulic fluids, but remember that brake fluid does not belong to this group. Chemically it is very different from hydraulic oil. Brake fluid cannot be mixed with or used as a substitute for any other type of fluid.

   f. **Power assist unit**—Device used as a booster in a brake system

   g. **Tandem**—Consisting of parts arranged one behind the other, usually acting in partnership

   h. **Vacuum**—Space without air; usually has different air pressures on each side that creates a force that can be used as an energy source

2. **Purpose of a power assist unit**—To increase or "boost" the force of the brake pedal, thereby decreasing the braking effort by the vehicle operator

3. **Basic types of power assist units (boosters)**

   a. **Vacuum power assist units**

      1) A vacuum is created to separate two different air pressures—lower vacuum pressure on one side of a piston or diaphragm and higher atmospheric pressure on the other side. This pressure differential of approximately 10 psi is used to assist the power of the brake unit.

      2) The vacuum source is typically from the intake manifold on gasoline engines or a vacuum pump on diesel engines.

      3) Vacuum boosters are used primarily on light-duty vehicles and some medium-duty vehicles, especially gasoline-powered.

## Information Sheet

b. **Hydraulic power assist units**

1) Assist in applying hydraulic force to the master cylinder, thereby increasing brake system effectiveness
2) Invoive an engine-driven hydraulic pump or power steering pump (more common) as the energy boost source
3) Used on the majority of medium-duty and heavy-duty vehicles with hydraulic brake systems

4. **Parts of a vacuum power assist unit**

Figure 1

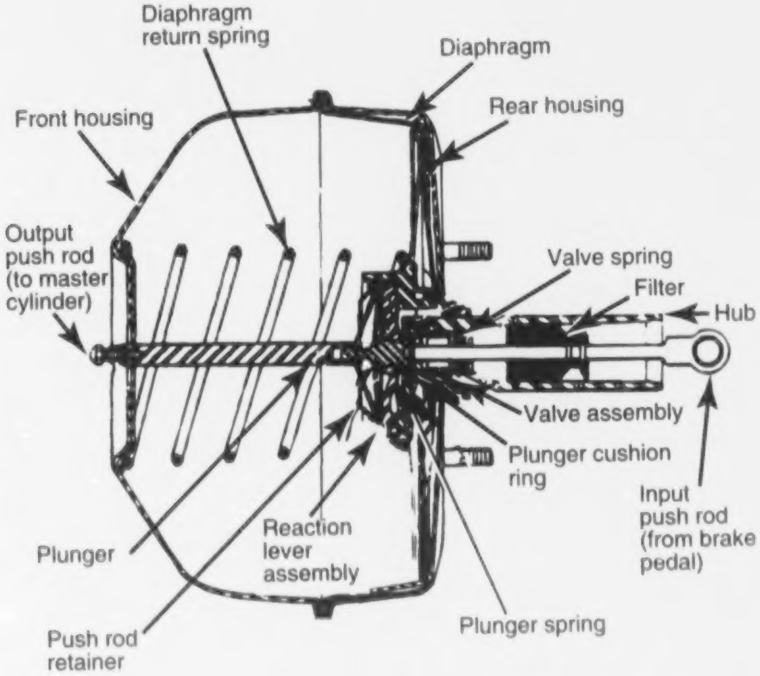

Diaphragm return spring
Diaphragm
Front housing
Rear housing
Output push rod (to master cylinder)
Valve spring
Filter
Hub
Valve assembly
Plunger cushion ring
Input push rod (from brake pedal)
Reaction lever assembly
Plunger
Push rod retainer
Plunger spring

Illustration used with permission of Ford Motor Company

## Information Sheet

### 5. Parts of a hydraulic power assist unit and related components

Figure 2

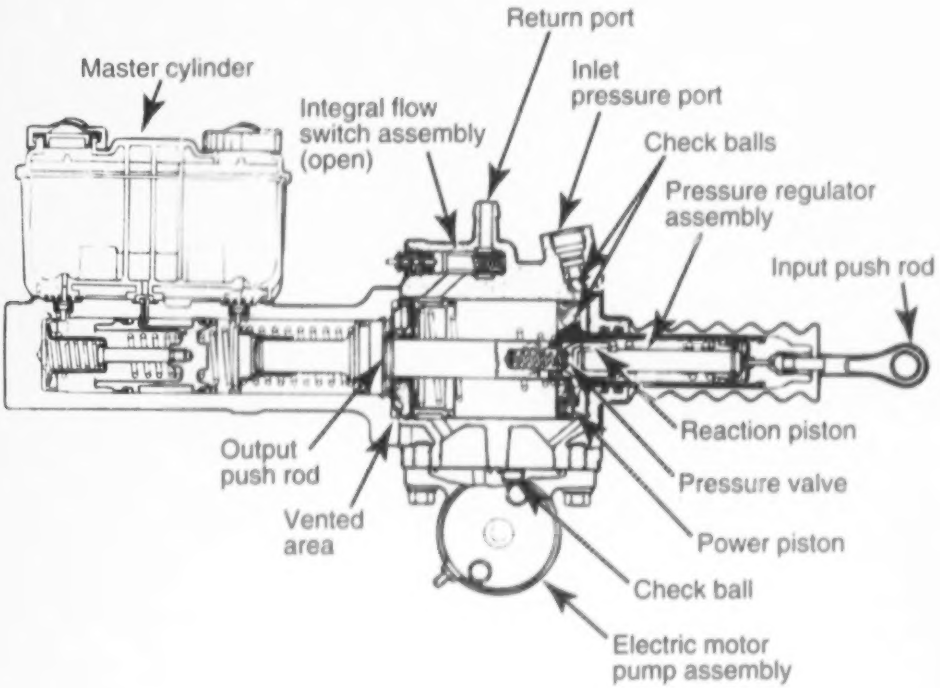

Return port
Master cylinder
Integral flow switch assembly (open)
Inlet pressure port
Check balls
Pressure regulator assembly
Input push rod
Reaction piston
Output push rod
Pressure valve
Vented area
Power piston
Check ball
Electric motor pump assembly

Illustration used with permission of Ford Motor Company

### 6. Functions of the basic parts of power assist units

a. **Input push rod**—Transfers force from brake pedal to booster piston

b. **Housing**—Protects components of the power assist unit

c. **Return spring(s)**—Returns vacuum diaphragm or hydraulic booster (power) piston to normal position when brakes are released

d. **Booster piston(s) and/or plunger**—Moves in response to pressure changes and transmits force from input to output push rods

e. **Control valve assemblies** (check balls, pressure regulators, filters, etc.)—Monitor and regulate energy sources (vacuum or hydraulic) in response to brake pedal application and release

f. **Output push rod**—Transmits force from booster piston or plunger to master cylinder piston

g. **Ports**—Allow for connections of the power assist unit with other brake components or related components

## Information Sheet

7. **Most common problems associated with power assist units**

   a. Hard brake pedal (excessive pedal pressure required to stop)

   b. Excessive brake pedal travel

   c. Sluggish application and release

   d. Grabby brakes (apparent off-on condition)

   e. Brakes fail to release

   f. Leaks (vacuum or hydraulic)

   g. Excessive pump noise (chatter, gurgle, etc.)

   h. Inoperative pump

   i. Improper operation of electrical system shown by brake lights, electro-hydraulic/electric pump, and any electrical accessories

8. **Adjustment of the brake booster push rod**

   a. The output push rod is typically adjusted using the adjustment screw on the push rod.

   b. Adjustment is necessary to maintain the correct relationship between the booster control valve plunger and the master cylinder piston.

   c. If the push rod is too long, it will prevent the master cylinder piston from completely releasing hydraulic pressure, causing brakes to drag.

   d. If the push rod is too short, it will cause excessive pedal travel and an undesirable clunk in the booster area.

   e. The master cylinder will have to be removed in order to gain access to the brake booster push rod.

## Information Sheet

f. A height gauge will need to be fabricated according to the manufacturer's specifications to check the correct push rod length.

Figure 3

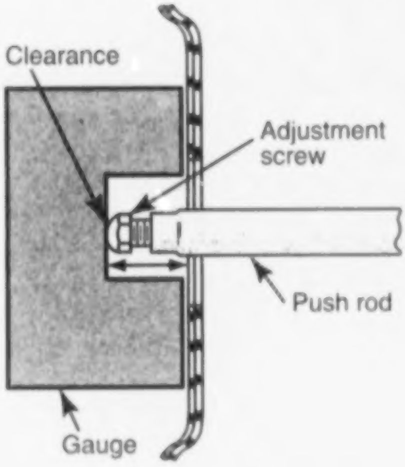


Illustration used with permission of Ford Motor Company

## 9. Operation of emergency back-up systems

### a. Electro-hydraulic pump

1) This is typically a vane-type pump that acts as the reserve or back-up power source to provide boost pressure whenever there is no flow through the hydraulic booster system. This would occur when the engine is off or a hose or belt is broken.

2) It is usually mounted to the bottom of the booster housing.

3) When the electro-hydraulic pump is operating, it draws fluid from the low pressure side of the booster (power) piston and delivers it to the high pressure or rear side.

4) Normal output pressure of the electro-hydraulic pump is about one-half of the main brake hydraulic pump or power steering pump.

5) It is typically used on medium- and heavy-duty vehicles.

### b. Accumulator

1) This device stores force from the power steering pump.

2) It will act as a reserve power source in case of failure from the main hydraulic source.

3) It is typically used on light- and medium-duty vehicles.

## Information Sheet

### 10. Use of brake fluid and power steering fluid on power assist units

a. The master cylinder and the brake system use standard glycol-based brake fluid.

b. The hydraulic power assist unit (booster) and the hydraulic brake pump or power steering pump use petroleum-based power steering fluid (hydraulic oil).

c. Do not mix brake fluid and power steering fluid. Fluid contamination results in seal damage which can lead to eventual loss of braking ability.

d. If the hydraulic power assist system becomes contaminated, flush with clean power steering fluid.

e. Always make sure you are replacing fluids with the correct type.

f. Do not reuse brake system fluids.

g. Always discard used fluids properly.

h. Do not spill brake fluids on brake linings or any chrome or painted surfaces.

i. Store both brake fluid and power steering fluid away from heat or flame, as they are both flammable.

j. Avoid skin and eye contact with both types of fluids. Wash with soap and water if skin contact occurs. In case of eye contact, immediately wash eyes for 15 minutes and call a physician or poison control center for additional instructions.

## Power Assist Units and Related Components
## Unit 4-B

### Job Sheet 1—Inspect and Test the Power Assist System and Emergency Brake Back-Up System; Determine Needed Repairs

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

| **Evaluation Criteria** | **Rating** |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Specifications are checked | ______ |
| Job ticket is filled out properly | ______ |
| Cleanup is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Power assist (booster) unit on hydraulic brake system to be worked on
6. Others—as recommended by instructor and equipment service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Move vehicle into shop. (Refer to Job Sheet 1, Unit 1-A if assistance is needed.)

☐ 4. Block wheels.

☐ 5. Identify type of power assist unit (vacuum or hydraulic).

☐ 6. Check operation of brake system and power assist unit.

   ☐ a. With engine off, push on brake pedal.

   ☐ b. Start engine with pedal down.

   ☐ c. When engine starts, brake pedal should move down about 1/4".

## Job Sheet 1

- ☐ d. Movement demonstrates that the power assist unit is operating correctly and is aiding in brake application.

☐ 7. Listen for any unusual noises. Noise may indicate air in the power steering fluid.

☐ 8. Turn engine off.

☐ 9. Inspect hydraulic and vacuum lines and hoses for cracks and leaks.

☐ 10. Check for loose bolts and brackets.

☐ 11. Check fluid level in the master cylinder, and service if needed.

☐ 12. If you are working on a hydraulic power assist unit,

- ☐ a. Check fluid level in the power steering pump, and service if needed.
- ☐ b. Inspect the power steering belt for cracks, breaks, and deterioration.

☐ 13. Record findings on the job ticket and discuss your findings with your instructor. Make the needed repairs/replacements as directed by your instructor.

☐ 14. Turn in job ticket when finished.

☐ 15. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

______________________________

______________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE |
|---|---|---|
| | | |
| TOTAL PARTS/MATERIALS | | |

**SPECIFICATIONS CHECKED**

School/Work Name ____________________

Address ____________________

Phone # ____________________

Date In ____________________

Date Out ____________________

## JOB TICKET

Customer Name ____________________

Customer Address ____________________

Customer Phone # ____________________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ____________________

Services/repairs made: ____________________

**LABOR**

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

____________________ Date ____________________

Technician ____________________

Supervisor ____________________

Unit 4-B, Job Ticket for Job Sheet 1

DT:B-B-105

DT:B-B-107

# Power Assist Units and Related Components
# Unit 4-B

## Job Sheet 2—Remove, Inspect, and Repair or Replace the Power Assist Unit

Name ______________________________ Attempt Number ______________

Date ______________________________ Overall Rating ______________

| **Evaluation Criteria** | **Rating** |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Specifications are checked | ______ |
| Repair/replacements are made correctly | ______ |
| Job ticket is filled out properly | ______ |
| Cleanup is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Container(s) to hold used fluids (brake and hydraulic oil)—may require separate containers
6. Power assist (booster) unit on hydraulic brake system to be worked on
7. Others—as recommended by instructor and equipment service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Move vehicle into shop. (Refer to Job Sheet 1, Unit 1-A if assistance is needed.)

☐ 4. Block wheels.

☐ 5. Remove negative battery cable.

☐ 6. Disconnect electrical connectors.

☐ 7. Disconnect brake fluid lines from master cylinder, and catch fluid in suitable container.

## Job Sheet 2

☐ 8. Remove hoses from the power assist (booster) unit, and catch fluid in a suitable container.

☐ 9. Remove mounting bolts and then the power assist unit. The master cylinder may also need to be removed in order to remove the power assist unit. Refer to the service manual.

  ☐ a. The vacuum power booster will need to be replaced as a unit if it is bad.

  ☐ b. The hydraulic power booster can be disassembled and repaired if required.

☐ 10. Remove seals on hydraulic power assist unit and replace with new seals.

☐ 11. Reinstall power assist unit, and torque mounting bolts to manufacturer's specifications.

☐ 12. Connect all lines and hoses.

☐ 13. Check all fluid levels to make sure they are adequate.

☐ 14. Bleed air from system. (Job Sheet 2, Unit 3-B)

☐ 15. Connect negative battery cable.

☐ 16. Check for proper brake and power assist operation.

☐ 17. Have instructor check your work.

☐ 18. Turn in job ticket when finished.

☐ 19. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ____________________

____________________

____________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE | |
|---|---|---|---|
| | | | |
| TOTAL PARTS/MATERIALS | | | |

**SPECIFICATIONS CHECKED**

School/Work Name ____________________

Address ____________________

Phone # ____________________

Date In __________

Date Out __________

## JOB TICKET

Customer Name ____________________

Customer Address ____________________

Customer Phone # ____________________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ____________________

| Services/repairs made: | LABOR | |
|---|---|---|
| | | |

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

____________________ Date __________

Technician __________

Supervisor __________

**Unit 4-B, Job Ticket for Job Sheet 2**

# Power Assist Units and Related Components
## Unit 4-B

### Job Sheet 3—Check Operation of Brake Failure Lights and Braking Warning Devices; Repair or Replace as Needed

Name ______________________ Attempt Number ______________

Date ______________________ Overall Rating ______________

| Evaluation Criteria | Rating |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Specifications are checked | ______ |
| Repair/replacements are made correctly | ______ |
| Job ticket is filled out properly | ______ |
| Cleanup is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Appropriate operator's manual
4. Job ticket or work order—one is included or use appropriate one provided at your facility
5. Wheel blocks
6. Test light
7. Volt-ohmmeter
8. Electronic scan tool
9. Hydraulic brake system to be worked on
10. Others—as recommended by instructor and service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual. Also check the operator's manual for information concerning brake failure lights and warning devices available on the vehicle.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Block wheels.

☐ 4. Turn ignition switch on, and check warning light operation.

☐ 5. Start engine, and check warning lights again. All lights should go off.

## Job Sheet 3

☐ 6. With engine running, apply brakes, and check brake failure light. Vehicle may also be equipped with a warning buzzer. Record all observations.

☐ 7. Install electronic scan tool, and follow manufacturer's instructions to check and identify failure codes.

☐ 8. Clear the system of all old codes after all problems have been corrected.

☐ 9. Check fuses and electrical connections.

☐ 10. Record all findings on the job ticket.

☐ 11. Set the parking brake, and remove the wheel blocks.

☐ 12. Check with your instructor about the need for a road test.

☐ 13. Turn in job ticket when finished.

☐ 14. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

______________________________

______________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE |
|---|---|---|
| | | |
| TOTAL PARTS/MATERIALS | | |

**SPECIFICATIONS CHECKED**

School/Work Name

Address

Phone #

Date In

Date Out

## JOB TICKET

Customer Name

Customer Address

Customer Phone #

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested:

Services/repairs made:

**LABOR**

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

Date

Technician

Supervisor

Unit 4-B, Job Ticket for Job Sheet 3

DT:B-B-113

# Air Foundation Brakes
# Unit 1-C

## Objective Sheet

### Unit Objective

After completing this unit, the student should be able to remove, inspect, and repair or replace slack adjusters, service brake chambers, and various foundation brake assemblies. The student should demonstrate these competencies by completing the job sheets and by scoring a minimum of 85 percent on the written test.

### Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to air foundation brakes with their definitions.
2. Distinguish among the basic components that make up air foundation brakes.
3. Match types of air foundation brakes with their descriptions.
4. Identify the parts of a cam foundation brake.
5. Identify the parts of a wedge foundation brake.
6. Identify the parts of a disc foundation brake.
7. Distinguish between the types of shoe assembly anchors.
8. Complete statements concerning brake linings, blocks, and pads.
9. Complete statements concerning guidelines for relining brakes.
10. Distinguish between the types of brake drum assembly arrangements.
11. Describe the types of slack adjusters.
12. List advantages of automatic slack adjusters.
13. Identify the parts of slack adjusters.
14. Distinguish between correct and incorrect guidelines for working on slack adjusters.
15. Identify the parts of a service brake chamber.
16. Arrange in order the steps in the operation of a typical service brake chamber.
17. Select true statements concerning guidelines for working on service brake chambers.
18. Discuss the main check points for inspecting foundation components.
19. Inspect, service, and adjust slack adjuster on front axle. (Job Sheet 1)

## Objective Sheet

20. Inspect, test, service, and replace service brake chamber. (Job Sheet 2)
21. Remove, inspect, and replace brake shoes, drum, and hardware for S-cam drum foundation brakes. (Job Sheet 3)
22. Remove, inspect, and replace brake shoes, drum, and hardware for wedge-type drum foundation brakes. (Job Sheet 4)
23. Inspect, clean, and measure brake calipers, pads, and rotors; replace pads if needed. (Job Sheet 5)

# Air Foundation Brakes
## Unit 1-C

### Information Sheet

1. **Terms and definitions**

   a. **Actuator**—Device that physically initiates the mechanical motion of a brake system component

   b. **Anchor pin**—Hardware used to retain brake shoes within the brake assembly

   c. **Brake drag**—Failure of one or more brakes to release immediately and/or completely after driver removes foot from brake treadle

   d. **Brake fade**—Reduction in braking force, usually caused by the inability of the brake lining to maintain its low temperature effectiveness as the brakes get hot

   e. **Caliper**—Clamping device used in a disc brake system that applies braking force to both sides of the rotor

   f. **Cam**—Mechanical part with an irregular shape so that the rotation of the part causes movement of another part

   g. **Clearance**—Distance between two parts

   h. **Clevis pin**—Pin connecting the arm of a slack adjuster to a brake chamber push rod

   i. **Coefficient of friction**—Number that describes the gripping capacity of a material

   j. **Diaphragm**—Flexible membrane that moves in response to changes in air pressure

   k. **Drum**—Part of wheel assembly that is engaged by the brake shoes to slow or stop the vehicle

   l. **Foundation brake**—Actual braking mechanism at each end of the axle

   m. **Parking brake**—Part of brake system designed to hold the vehicle in place when vehicle is parked

   n. **Recovery**—Return of brake lining to its previous (pre-fade) friction level after a hot run

   o. **Return spring**—Device that retracts brake shoes upon release of the brake treadle

   p. **Service brake**—Portion of the brake system used for normal brake applications

   q. **Slack adjuster**—Device that provides a means of adjusting clearance between brake shoes and drum to compensate for lining wear

   r. **Spring brake**—Tandem-chamber brake actuator that incorporates an air-applied service brake chamber and an air-release/spring-applied parking or emergency brake chamber; used on rear axles

   s. **Stroke**—Linear distance traveled by a brake chamber push rod or slack adjuster arm during brake application

## Information Sheet

2. **Basic components that make up air foundation brakes**

   a. **Brake chamber or actuator**

      1) Converts air pressure into mechanical force

      2) Joins the air system to the mechanical brake system

   b. **Slack adjuster or wedge assembly**

      1) Transfers movement from brake chamber push rod to apply the brakes

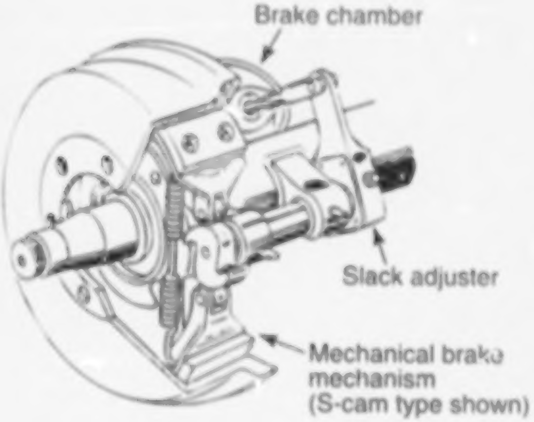
      2) Serves as the link between the brake chamber or actuator and the mechanical brake mechanism

   c. **Mechanical brake mechanism**

      1) Applies the force needed to stop the vehicle

      2) Includes the brake linings (friction material), brake drums and shoes, or brake discs (rotors) and pads

Figure 1


Brake chamber
Slack adjuster
Mechanical brake mechanism (S-cam type shown)

Courtesy of AlliedSignal Bendix

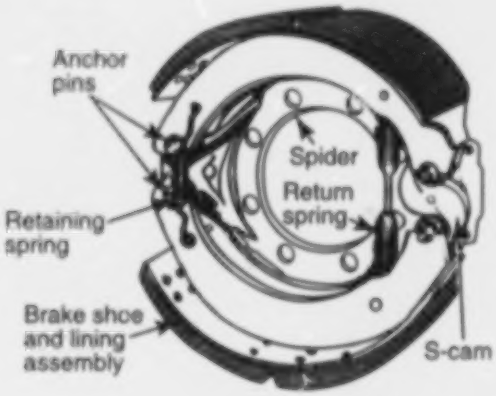
## Information Sheet

### 3. Types of air foundation brakes

a. **Drum brakes**

1) **Cam or S-cam brake**—Is linked to the air system and service brake chamber by the slack adjuster which is installed on the brake camshaft; when torsional force from the slack adjuster is applied to the camshaft, the cam spreads the brake shoes, forcing the brake lining into contact with the brake drum, thereby stopping the vehicle; most common design of air foundation brakes used today

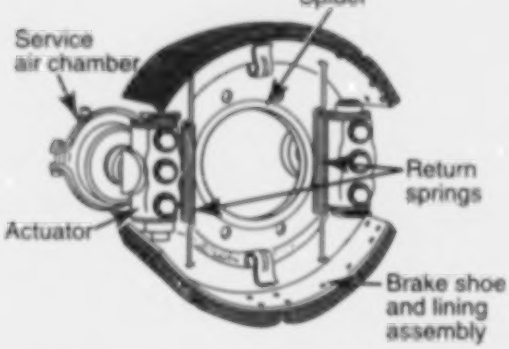
Figure 2


Anchor pins
Spider
Return spring
Retaining spring
Brake shoe and lining assembly
S-cam

Courtesy of Meritor Automotive, Inc.

2) **Wedge brake**—Does not use slack adjusters or camshafts; instead uses a wedge/roller mechanism that spreads the brake shoes and forces them against the drum; the wedge and roller mechanism is enclosed within the actuator and chamber tube.

Figure 3

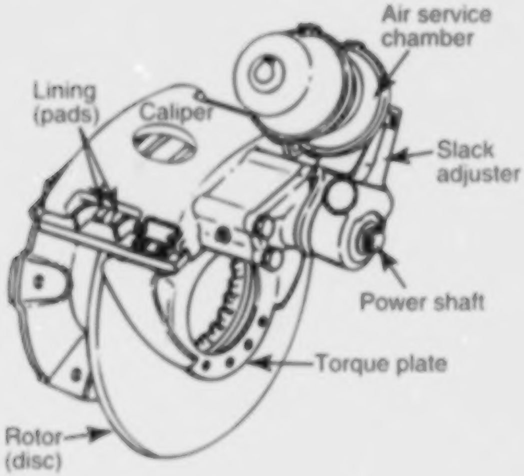

Spider
Service air chamber
Return springs
Actuator
Brake shoe and lining assembly

Courtesy of Meritor Automotive, Inc.

## Information Sheet

b. **Disc brake**—Uses a powershaft screw and nut to force the piston and inboard lining (pad) against the disc (rotor), this engages the caliper which puts the outboard pad into contact with the disc. The result is clamping force on both sides of the disc.

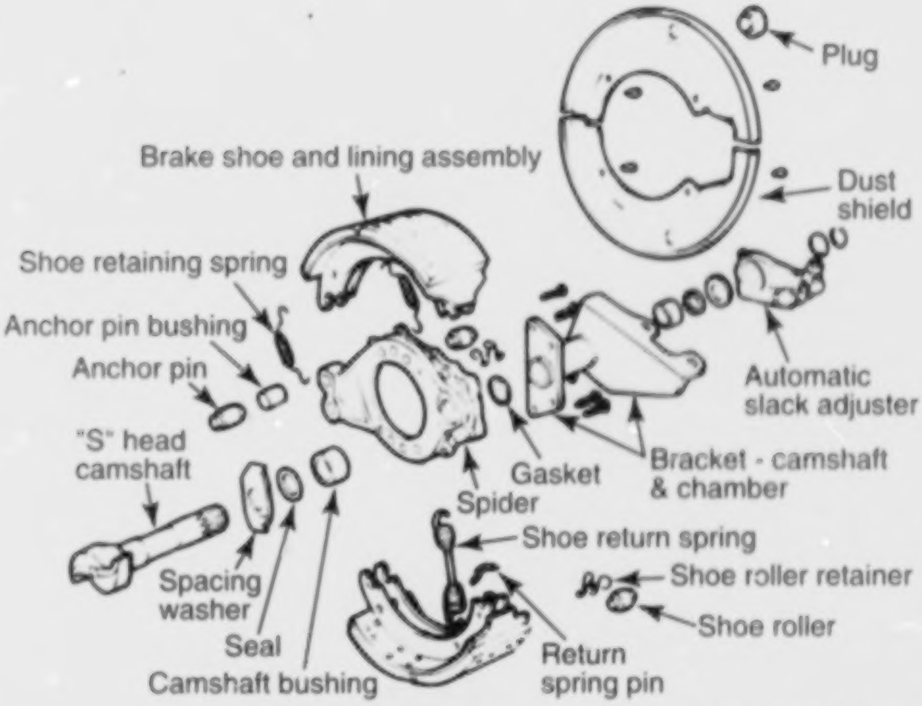
Figure 4


Air service chamber
Lining (pads)
Caliper
Slack adjuster
Power shaft
Torque plate
Rotor (disc)

Courtesy of Haldex Midland Services

4. **Parts of a cam foundation brake**

Figure 5

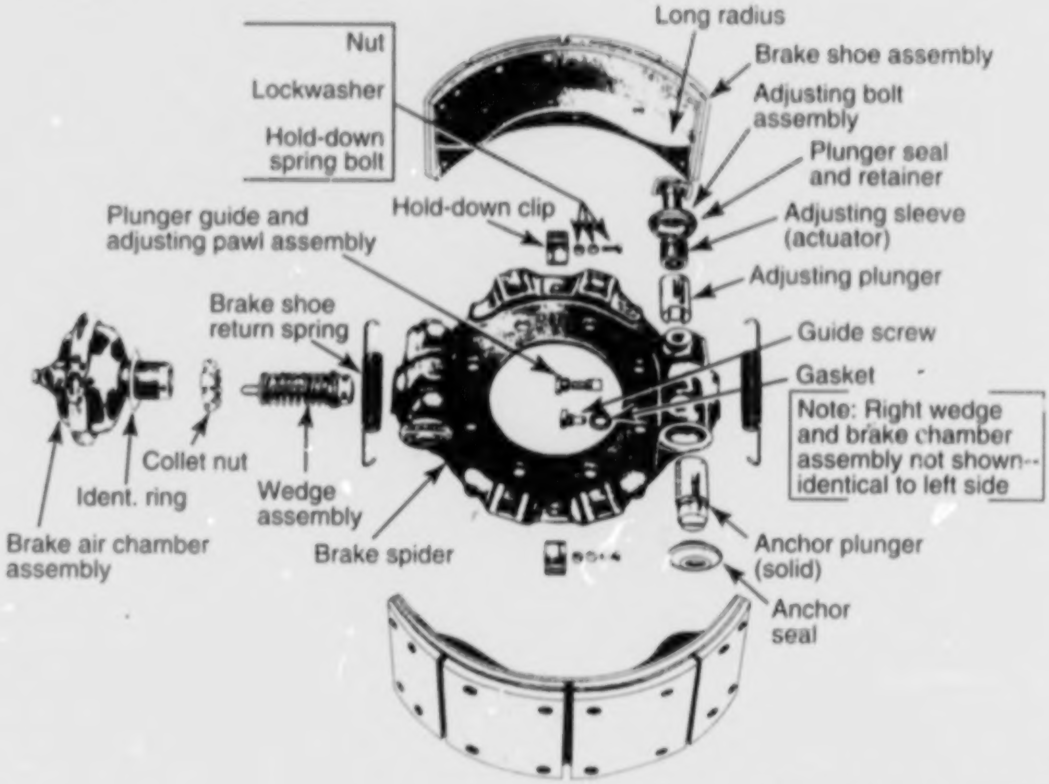

Plug
Brake shoe and lining assembly
Dust shield
Shoe retaining spring
Anchor pin bushing
Anchor pin
Automatic slack adjuster
"S" head camshaft
Gasket
Bracket - camshaft & chamber
Spider
Shoe return spring
Shoe roller retainer
Spacing washer
Shoe roller
Seal
Return spring pin
Camshaft bushing

Courtesy of Meritor Automotive, Inc.

## Information Sheet

### 5. Parts of a wedge foundation brake

Figure 6


Long radius
Brake shoe assembly
Nut
Lockwasher
Hold-down spring bolt
Adjusting bolt assembly
Plunger seal and retainer
Hold-down clip
Plunger guide and adjusting pawl assembly
Adjusting sleeve (actuator)
Adjusting plunger
Brake shoe return spring
Guide screw
Gasket
Collet nut
Ident. ring
Wedge assembly
Brake air chamber assembly
Brake spider
Anchor plunger (solid)
Anchor seal

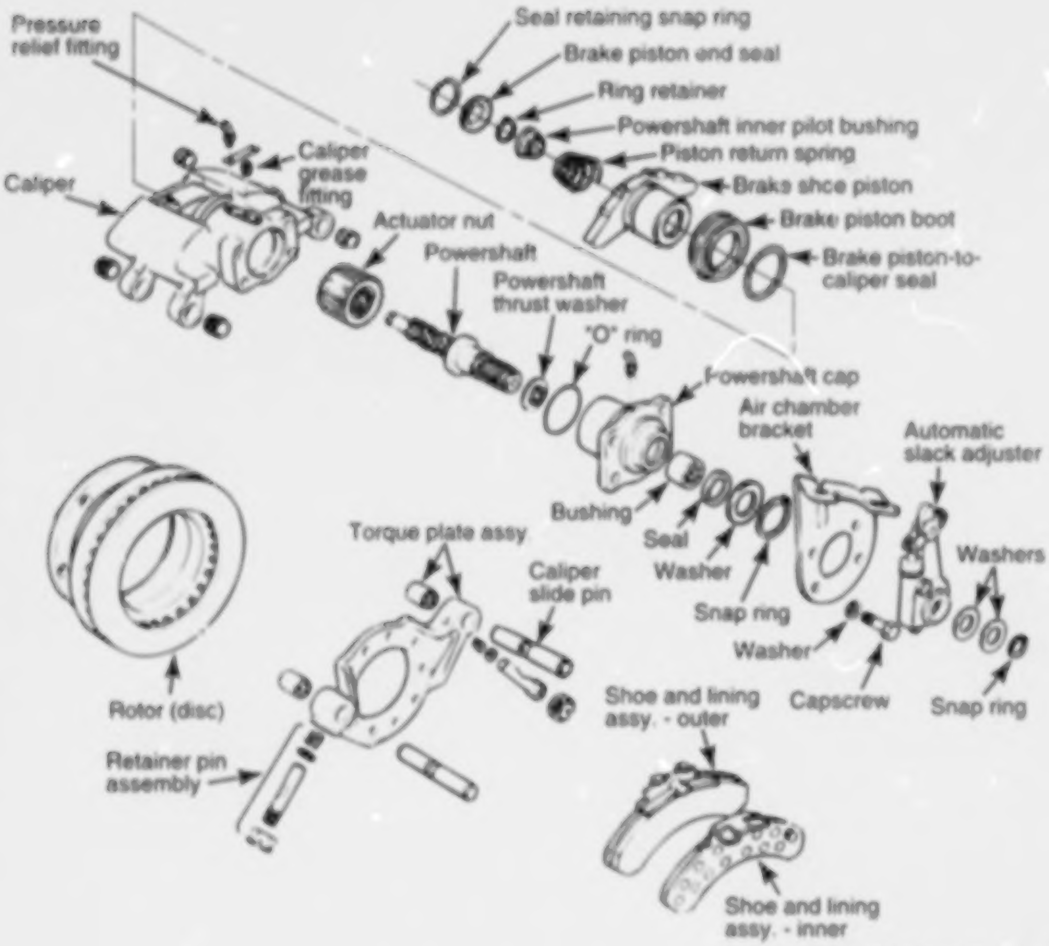
Note: Right wedge and brake chamber assembly not shown--identical to left side

Courtesy of Meritor Automotive, Inc

## Information Sheet

### 6. Parts of a disc foundation brake

Figure 7


Pressure relief fitting
Caliper
Caliper grease fitting
Actuator nut
Powershaft
Powershaft thrust washer
"O" ring
Seal retaining snap ring
Brake piston end seal
Ring retainer
Powershaft inner pilot bushing
Piston return spring
Brake shoe piston
Brake piston boot
Brake piston-to-caliper seal
Powershaft cap
Air chamber bracket
Automatic slack adjuster
Bushing
Seal
Washer
Snap ring
Washers
Washer
Capscrew
Snap ring
Torque plate assy.
Caliper slide pin
Rotor (disc)
Retainer pin assembly
Shoe and lining assy. - outer
Shoe and lining assy. - inner

Courtesy of Meritor Automotive, Inc.

## Information Sheet

### 7. Types of shoe assembly anchors

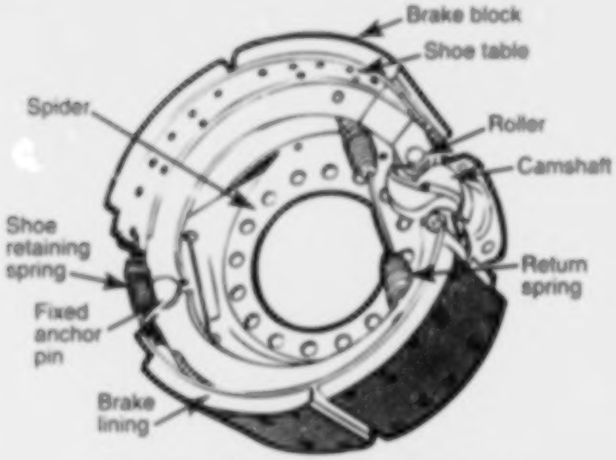
#### a. Fixed anchor pins

1) Normally easier to service because pins do not have to be removed for brake shoe lining changes

2) Have open anchor pin openings and a retaining spring to allow for quick relines

3) May use single or double pins

Figure 8


Brake block
Shoe table
Spider
Roller
Camshaft
Shoe retaining spring
Return spring
Fixed anchor pin
Brake lining

Credit: Eaton® Cam Brakes (EB and ES models)

Courtesy of Mack Trucks, Inc.

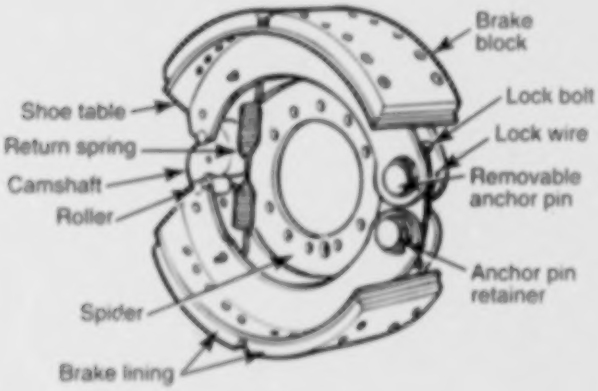
b. **Removable anchor pins**

1) Have closed anchor pin openings and anchor pins that must be removed before brake shoe linings can be changed

2) May be difficult to service because pins often become seized in the pin openings and will have to be forced out

3) May use single or double pins

Figure 9


Brake block
Lock bolt
Lock wire
Removable anchor pin
Anchor pin retainer
Shoe table
Return spring
Camshaft
Roller
Spider
Brake lining

Credit: Meritor ™ "P" Brake

Courtesy of Mack Trucks, Inc.

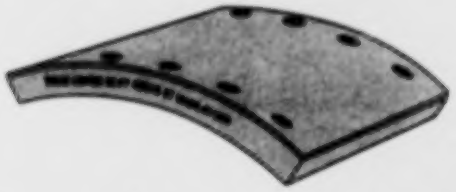
## 8. Brake linings, blocks, and pads

a. Brake lining materials are made of special friction material that is able to withstand the heat created from the braking effort.

b. Until recently, asbestos was the primary friction material used on brake linings. Although new linings have little or no asbestos, all safety precautions and asbestos warnings should still be followed when working on brake linings. New brake linings still contain materials that should not be inhaled.

c. Friction materials are identified by a stencil on its edge that gives the name of the manufacturer, material identification, and friction class.

Figure 10



Courtesy of AlliedSignal Bendix

## Information Sheet

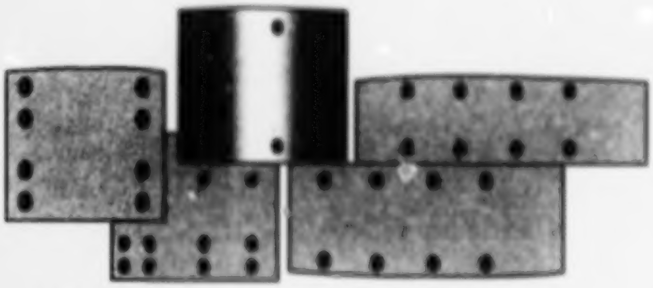
d. The friction class is indicated by two letters. The first letter represents the normal coefficient of friction, and the second represents the hot coefficient of friction.

Table 1—Friction Code Chart

| LETTER | NUMERICAL RANGE |
|---|---|
| D | Over .150 but less than .250 |
| E | .250 to .350 |
| F | .351 to .450 |
| G | .451 to .550 |
| H | Over .550 |

e. Brake linings and blocks differ in that it takes two brake blocks to line one shoe, while only one lining is needed per shoe.

Figure 11



Courtesy of AlliedSignal Bendix

f. Brake block is generally 3/4" thick and is commonly used on heavy-duty Class 8 vehicles.

g. Brake lining is generally 1/2" thick and is commonly used on smaller vehicles.

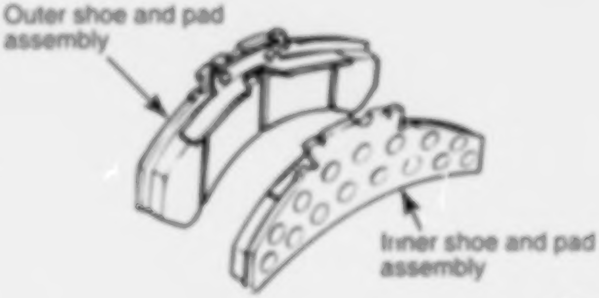
h. Brake blocks are typically wider than linings because they are used on vehicles that have larger brake drums.

i. Brake blocks and linings are usually riveted onto the shoe using a special riveting tool. Follow the riveting sequence specified by the manufacturer.

j. Brake pads are used on disc foundation brakes.

k. Brake pads are available as a shoe and lining reline kit with the friction material already bonded to the shoe.

Figure 12



Courtesy of Meritor Automotive, Inc.

l. When replacing friction material on one side of an axle, always replace the material on the other side at the same time to ensure balanced braking.

m. While it is recommended that a matched set of lining be used on each wheel, under some conditions a combination of different lining materials may be desirable.

9. **Guidelines for relining brakes**

a. Make sure that brake shoes are in good condition.

   1) Table should be flat, without distortion.

   2) There should be no undue wear at the anchor and roller end.

   3) Rivet holes should not be elongated.

b. Prior to disassembly, check the lining wear on all brakes.

   1) If wear is even, the brake balance is correct.

   2) If wear is uneven, investigate for other system problems.

c. Use the friction material specified by the original equipment manufacturer (OEM) for all relines.

d. Replace the full hardware kit and change the cam bushings, especially if a difference in wear is noted between the two shoes.

e. When disassembling the brakes for reline, note the condition of each part.

f. Never replace a failed component without tracing the reason for the failure. It will just fail again if the root cause is not identified and corrected.

g. Make sure that the shoe is not stretched.

h. Check for gaps between the lining and the shoe table.

## Information Sheet

### 10. Types of brake drum assembly arrangements

a. **Inboard**—Wheel and drum assembly must be removed as a unit in order for drum to be removed from hub

b. **Outboard**—Drum may be removed without having to remove hub assembly; is quicker for brake service

Figure 13

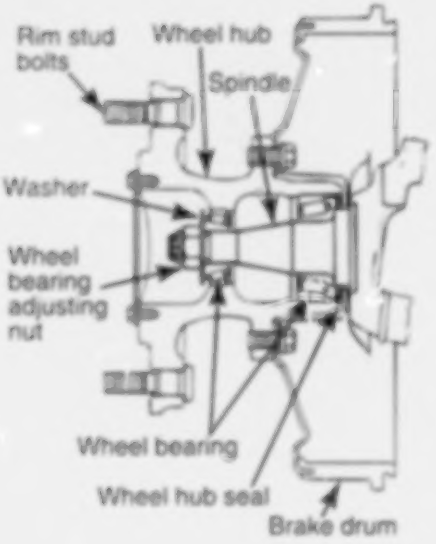
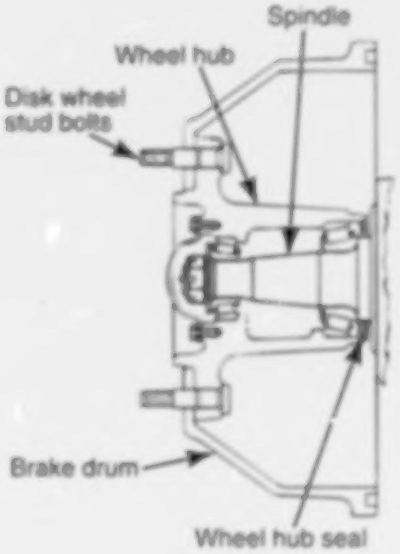

Rim stud bolts
Wheel hub
Spindle
Washer
Wheel bearing adjusting nut
Wheel bearing
Wheel hub seal
Brake drum

Figure 14


Spindle
Wheel hub
Disk wheel stud bolts
Brake drum
Wheel hub seal

### 11. Types of slack adjusters

a. **Manual**—Must be periodically checked and readjusted to compensate for brake lining wear

b. **Automatic**—Automatically adjusts the clearance between the brake linings and the brake drum or rotor during normal service braking applications

### 12. Advantages of automatic slack adjusters

a. Automatic brake adjustment

b. Reduced downtime and maintenance costs

c. Improved brake balance

d. Reduced chamber travel and less air consumption

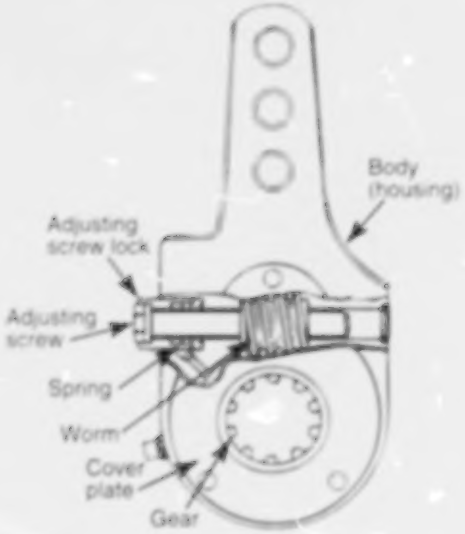
e. Consistent, reliable spring brake engagement

## Information Sheet

13. **Parts of slack adjusters**

a. Manual slack adjuster

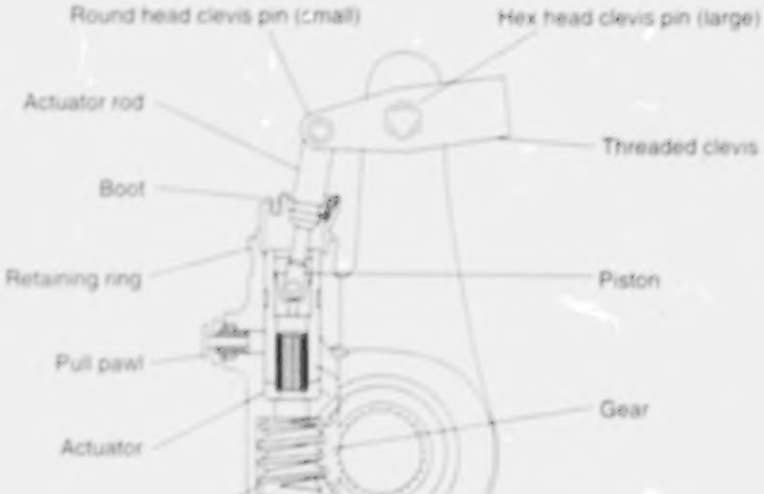
Figure 15


Body
(housing)
Adjusting
screw lock
Adjusting
screw
Spring
Worm
Cover
plate
Gear

Courtesy of Navistar International Transportation Corp.

b. Automatic slack adjuster

Figure 16


Round head clevis pin (small)
Hex head clevis pin (large)
Actuator rod
Threaded clevis
Boot
Retaining ring
Piston
Pull pawl
Gear
Actuator
Worm
Grease fitting

Courtesy of Mentor Automotive, Inc.

## Information Sheet

### 14. Guidelines for working on slack adjusters

a. All slack adjusters convert the linear force of the brake chamber push rod into a twisting force that turns the brake camshaft.

b. The worm and gear mechanism inside the slack adjuster is used for brake clearance adjustment.

c. Slack adjusters are available in several arm configurations, lengths, and spline types.

d. Replace slack adjusters with the same size and type as the original equipment.

e. Slack adjuster numbers represent maximum torque rating.

Example: A type 20 unit is rated for a maximum of 20,000 inch-pounds of torque.

f. Never mix automatic slack adjusters with manual slack adjusters on the same vehicle.

g. Avoid mixing automatic slack adjusters from different manufacturers on the same vehicle.

h. Never mix automatic slack adjusters from different manufacturers on the same axle.

i. Follow the manufacturer's instructions for adjustment of slack adjusters. Make sure you have the proper templates and measuring tools required for the job.

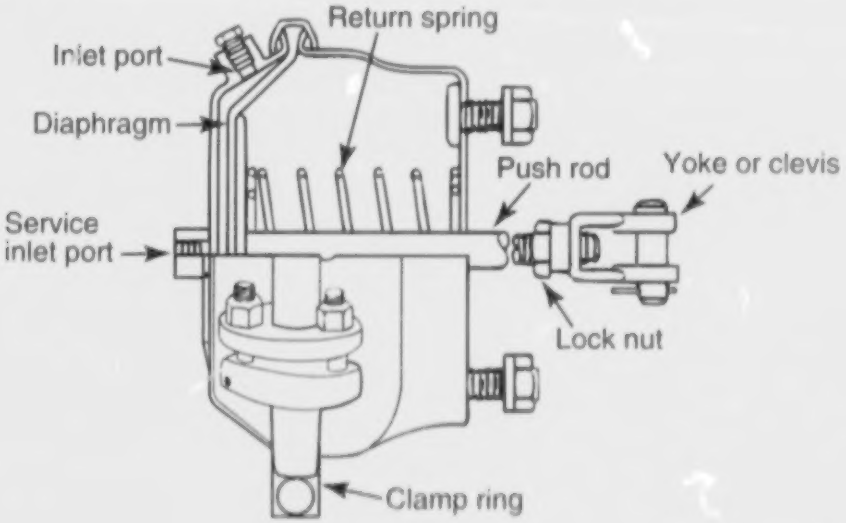
j. Follow all safety precautions, especially as they relate to the service brake chamber and the spring brake chamber which are connected to the slack adjuster. Prior to removing or installing a slack adjuster,

   1) Make sure the spring brakes are mechanically caged or released with air.

   2) Block the wheels and release all brakes.

### 15. Parts of a service brake chamber (front axle)

Figure 17



Courtesy of Haldex Midland Services

## Information Sheet

### 16. Operation of a typical service brake chamber

a. Controlled air pressure enters the brake chamber through the inlet port.

b. Air pressure acts upon the diaphragm, moving the push rod forward.

c. Push rod acts upon either the slack adjuster (cam brakes) or the wedge assembly (wedge brakes).

Note: The greater the air pressure admitted to the brake chamber, the greater the force applied to the push rod.

d. When air pressure is released from the brake chamber, the push rod return spring in combination with the brake shoe return springs return the diaphragm and push rod assembly to their released position.

Note: Brake chambers are sized by the effective area of the diaphragm. For example, a type 16 brake chamber has an effective diaphragm area of 16 square inches.

### 17. Guidelines for working on service brake chambers

a. Always maintain the brake chambers to their original performance condition.

b. If the chamber return springs need replacement, the springs should be replaced with springs of the proper spring load.

c. Always replace the return spring on both chambers on an axle.

d. Replace all diaphragms on the vehicle at the same time.

e. Prior to installing a new brake chamber, the new push rod should be compared to the length of the old push rod with the excess rod cut off with a hacksaw.

f. Make sure the chamber push rods are in line with the slack adjusters.

g. Ideally, the chamber push rod length should be adjusted so that when the chamber reaches half its maximum stroke, a 90° angle is formed between the slack adjuster and the chamber push rod.

### 18. Main check points for inspecting foundation components

a. **Springs—Return and retaining**

1) Check to see that the shoes fully retract upon brake release.

2) Replace at each reline.

b. **Rollers**

1) Discard pitted, corroded, or flat spotted shoe rollers.

2) Follow the manufacturer's recommendations concerning the use of oversize shoe rollers to correct sticking cams and cam rollover.

## Information Sheet

c. **Cam shafts, bushings, and brackets**

   1) Inspect the cam and its shaft for irregular surfaces, flat spotting, cracks, wear, and corrosion. Make sure the cam surface, bearing journals, and splines are smooth and free of ridges.

   2) Wiggle the cam up and down to check for radial play, and in and out to check for end play. Check with a dial indicator if any play is felt.

   3) Replace cam bushings and seals at each reline.

   4) Inspect the cam shaft bracket for broken welds, cracks, loose mounting fasteners, bending, and misalignment.

d. **Anchor pins**

   1) Inspect for roundness, corrosion, and wear.

   2) On anchor pins that must be removed prior to brake shoe removal, use a suitable brass drift, special press, or puller to drive out the pins. Never use a steel hammer.

   3) Never heat the spider to remove stubborn anchor pins. This destroys the metal's tempering and will cause permanent distortion. Instead use a light, penetrating oil and gently tap them out with a suitable tool.

e. **Spider**

   1) Check for elongated anchor pin holes, cracks, and proper alignment.

   2) Also check the single anchor pin spider for anchor pin wear and looseness in the spider.

f. **Dust shield**—Check for tightness, rust, and distortion.

g. **Brake drum**—Check for scoring, cracking, excessive inner diameter, and/or runout.

h. **Rotor**—Check for scoring, cracking, and uneven thickness.

i. **Brake chamber**—Check for cracks, clogged vent holes, bent push rods, and for loose mountings, air fittings, and clamp rings.

j. **Slack adjuster**—Check for cracks, damaged splines, worn clevis pin bushings, and sticky adjustment nuts.

# Air Foundation Brakes
# Unit 1-C

## Job Sheet 1—Inspect, Service, and Adjust Slack Adjuster on Front Axle

Name ____________________ Attempt Number __________

Date ____________________ Overall Rating __________

| **Evaluation Criteria** | **Rating** |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Specifications are checked | ______ |
| Adjustments/replacements are made correctly | ______ |
| Job ticket is filled out properly | ______ |
| Cleanup is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Snap ring plier set
6. Jack and safety stands
7. Air brake system to be worked on
8. Others—as recommended by instructor and equipment service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Move vehicle into shop.

☐ 4. Apply the parking brake.

☐ 5. Block the vehicle wheels.

☐ 6. Raise the vehicle and support with safety stands.

☐ 7. Mark the position of the air brake slack adjuster to the camshaft by drawing a straight line on both parts.

### Job Sheet 1

☐ 8. Remove retainers and clevis pins.

☐ 9. Fully release the air brake slack adjuster and adjust as specified in the service manual. The exact procedure varies according to the manufacturer.

  ☐ a. To release a manual slack adjuster, put a wrench on the adjusting nut and press in to release the locking collar. The wormshaft adjusting nut can be rotated to adjust the slack adjuster.

  ☐ b. To release an automatic slack adjuster, remove lock clip. Using a wrench, turn manual adjusting nut end of the worm gear clockwise until brake is fully released.

☐ 10. Remove snap ring and washer from s-cam shaft end and slide slack adjuster off shaft.

☐ 11. Clean and inspect slack adjuster. Check splines for damage or wear.

☐ 12. Rotate the air brake automatic slack adjuster adjusting nut counterclockwise using a pound-inch torque wrench. Turn the gear 360° making sure that the torque remains less than 40 lb.

☐ 13. If the torque specification is exceeded, replace with a new slack adjuster. Check with your instructor about the need for a new slack adjuster.

☐ 14. Lubricate the camshaft splines using an anti-seize lubricant.

☐ 15. Install air brake slack adjuster on camshaft.

☐ 16. Install washer and snap ring.

☐ 17. Rotate slack adjuster adjusting hex clockwise until the slack adjuster arm hole lines up with the air brake chamber clevis hole. The marks made on the brake slack adjuster and camshaft should align.

☐ 18. Install brake chamber clevis pins.

☐ 19. Adjust the slack adjuster with procedure used earlier.

☐ 20. Grease slack adjuster and s-cam bushings.

☐ 21. Remove the safety stands and lower the vehicle.

☐ 22. Release the parking brakes and check brake operation.

☐ 23. Set parking brake and remove wheel blocks.

☐ 24. Record work on job ticket.

## Job Sheet 1

☐ 25. Turn in job ticket when finished.

☐ 26. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

______________________________

______________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| TOTAL PARTS/MATERIALS | | | |

### SPECIFICATIONS CHECKED

| | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |

School/Work Name ____________________

Address ____________________

Phone # ____________________

Date In ____________

Date Out ____________

## JOB TICKET

Customer Name ____________________

Customer Address ____________________

Customer Phone # ____________________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ____________________

____________________

Services/repairs made: ____________________

| LABOR | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

____________________ Date ____________

Technician ____________

Supervisor ____________

Unit 1-C, Job Ticket for Job Sheet 1

# Air Foundation Brakes
# Unit 1-C

## Job Sheet 2—Inspect, Test, Service, and Replace Service Brake Chamber

Name ______________________________ Attempt Number ______________

Date ______________________________ Overall Rating ______________

| Evaluation Criteria | Rating |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Specifications are checked | ______ |
| Repairs/replacements/adjustments are made correctly | ______ |
| Job ticket is filled out properly | ______ |
| Cleanup is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Soap solution with brush
6. Air brake system to be worked on
7. Others—as recommended by instructor and equipment service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Move vehicle into shop.

☐ 4. Apply the parking brake.

☐ 5. Block the vehicle wheels.

☐ 6. Start engine and charge the air system to the governor cut-out point.

☐ 7. Have an assistant apply and hold the brake pedal.

☐ 8. Apply a soap solution around the front air brake chamber clamp and breather holes to inspect for leaks.

## Job Sheet 2

☐ 9. Record findings on job ticket.

☐ 10. If bubbles appear, overhaul or replace the front air brake chamber.

☐ 11. Disconnect air line from chamber.

☐ 12. Remove clevis pin from slack adjuster and loosen chamber mounting bolts and remove chamber.

☐ 13. Replace diaphragm in brake chamber.

☐ 14. Mark the pressure cap and chamber assembly in relation to the clamp ring assembly.

☐ 15. Remove air brake chamber clevis and nut.

☐ 16. Pull out the push rod and clamp it using locking-type pliers.

☐ 17. Remove nuts and bolts to disassemble the clamp ring assembly.

☐ 18. Remove pressure cap and diaphragm.

☐ 19. Inspect chamber assembly for corrosion and replace corroded parts.

☐ 20. Install new diaphragm and reassemble.

☐ 21. Reinstall brake chamber on vehicle and adjust brake.

☐ 22. Record work on job ticket.

☐ 23. Remove wheel blocks.

☐ 24. Turn in job ticket when finished.

☐ 25. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

______________________________

______________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| **TOTAL PARTS/MATERIALS** | | | |

**SPECIFICATIONS CHECKED**

| | ✓ |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |

School/Work Name ______________________

Address ______________________

Phone # ______________________

Date In ____________

Date Out ____________

## JOB TICKET

Customer Name ______________________

Customer Address ______________________

Customer Phone # ______________________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ______________________

Services/repairs made: ______________________

| | **LABOR** | |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

______________________ Date ____________

Technician ____________

Supervisor ____________

Unit 1-C, Job Ticket for Job Sheet 2

DT:B-C-27

# Air Foundation Brakes
## Unit 1-C

### Job Sheet 3—Remove, Inspect, and Replace Brake Shoes, Drum, and Hardware for S-Cam Drum Foundation Brakes

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

| **Evaluation Criteria** | **Rating** |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Specifications are checked | ______ |
| Repair/replacements/adjustments are made correctly | ______ |
| Job ticket is filled out properly | ______ |
| Cleanup is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Jack and safety stands
6. Wheel dolly
7. Axle nut set
8. Wet type brake parts cleaner
9. Measuring caliper tool
10. Air brake system to be worked on
11. Others—as recommended by instructor and service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Move vehicle into shop.

☐ 4. Apply the parking brake.

☐ 5. Block the vehicle wheels.

☐ 6. Raise the vehicle and support with safety stands.

## Job Sheet 3

☐ 7. Cage the rear air brake chambers according to the service manual instructions. Follow all safety precautions.

**Caution: Do not attempt to cage the power spring if the brake chamber shows structural damage. Remove entire unit and replace with new unit. Even on good brake chambers, caging the power spring is serious, dangerous work. Make sure you know what you're doing before attempting this.**

☐ 8. Fully release the brake slack adjuster so that the shoes retract and the brake drum will clear the brake linings.

☐ 9. Remove wheel and tire assembly if repairing outboard mounted brake drums.

☐ 10. Slide the brake drum from the hub.

☐ 11. Inspect brake drum and discuss with your instructor whether drum should be turned or replaced with new drum.

☐ 12. For inboard mounted brake drums, refer to service manual.

☐ 13. Use wheel dolly to remove wheel hub assembly.

☐ 14. Clean brake drum, shoes, and hardware using brake parts cleaner.

Caution: **When servicing brake parts, do not create dust by grinding or sanding brake shoes, by cleaning brake parts with a dry brush, or by using compressed air. Brake shoes may contain asbestos fibers that can cause serious bodily harm.**

☐ 15. Push down on the bottom brake shoe and remove the brake shoe roller.

☐ 16. Lift the bottom brake shoe, release the tension on the brake shoe return spring, and remove the brake shoe return springs and shoes.

☐ 17. Inspect the brake hardware for cracks and damage; replace needed parts.

☐ 18. Measure brake shoe anchor pins and shoe roller hole span distance.

☐ 19. Record findings on job ticket.

☐ 20. Replace with new brake shoes if needed.

☐ 21. Install brake shoes back on spider assembly.

☐ 22. Install new brake shoe return spring by following service manual procedure.

## Job Sheet 3

☐ 23. Measure and compare brake shoe to drum diameter making sure drums will go over shoes.

☐ 24. Install new or reconditioned brake drum.

☐ 25. Adjust the wheel bearings (if needed).

☐ 26. Install tire and wheel assemblies

☐ 27. Remove safety stands and lower vehicle.

☐ 28. Start the engine and charge the air system to the governor cut-out point; stop engine.

☐ 29. Adjust brakes as directed in service manual.

☐ 30. Uncage the rear air brake chambers. Follow all safety precautions.

☐ 31. Check for proper brake operation.

☐ 32. Set parking brake and remove the wheel blocks.

☐ 33. Record work on job ticket.

☐ 34. Turn in job ticket when finished.

☐ 35. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

______________________________________________

______________________________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE |
|---|---|---|
| | | |
| TOTAL PARTS/MATERIALS | | |

**SPECIFICATIONS CHECKED**

School/Work Name

Address

Phone #

Date In

Date Out

## JOB TICKET

Customer Name

Customer Address

Customer Phone #

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested:

Services/repairs made:

**LABOR**

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

Date

Technician

Supervisor

Unit 1-C, Job Ticket for Job Sheet 3

DT:B-C-33

# Air Foundation Brakes
# Unit 1-C

## Job Sheet 4—Remove, Inspect, and Replace Brake Shoes, Drum, and Hardware for Wedge-Type Drum Foundation Brakes

Name ________________ Attempt Number ________

Date ________________ Overall Rating ________

| Evaluation Criteria | Rating |
|---|---|
| Directions are followed | |
| Safety procedures are followed | |
| Service manual is used properly | |
| Parts are inspected accurately | |
| Specifications are checked | |
| Repairs/replacements/adjustments are made correctly | |
| Job ticket is filled out properly | |
| Cleanup is adequate | |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Jack and safety stands
6. Wheel dolly
7. Axle nut set
8. Wet type brake parts cleaner
9. Measuring caliper tool
10. Brake spring pliers
11. Wire brush
12. High-temperature waterproof grease
13. Air brake system to be worked on
14. Others—as recommended by instructor and service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Move vehicle into shop.

☐ 4. Apply the parking brake.

☐ 5. Block the vehicle wheels.

## Job Sheet 4

☐ 6. Raise the vehicle and support with safety stands.

☐ 7. Start engine, charge the air system, and release the parking brakes.

☐ 8. Cage the rear spring brake chambers according to the service manual instructions. Follow all safety precautions.

> **Caution: Do not attempt to cage the power spring if the brake chamber shows structural damage. Remove entire unit and replace with new unit. Even on good brake chambers, caging the power spring is serious, dangerous work. Make sure you know what you're doing before attempting this.**

☐ 9. Fully adjust brake shoes off to give clearance to remove drum.

☐ 10. Remove wheel and tire assembly when repairing outboard mounted brake drums.

☐ 11. Slide the brake drum from the hub.

☐ 12. Inspect brake drum and discuss with your instructor whether drum should be turned or replaced with new drum.

☐ 13. For inboard mounted brake drums, refer to service manual.

☐ 14. Use wheel dolly to remove wheel hub assembly.

☐ 15. Using brake spring pliers, remove shoe return springs.

☐ 16. Remove brake shoe assemblies.

☐ 17. Remove plunger guide screws and gaskets from plunger housing.

☐ 18. If brake is automatic adjusting, remove pawl assembly. It may be necessary to use a magnet to remove the adjusting pawl.

☐ 19. Pry plunger seals loose and remove anchor plunger, adjusting plunger, adjusting sleeves, and adjusting bolts.

☐ 20. Inspect and clean all parts and hardware.

> Caution: **When servicing brake parts, do not create dust by grinding or sanding brake shoes, by cleaning brake parts with a dry brush, or by using compressed air. Brake shoes may contain asbestos fibers that may cause serious bodily harm.**

☐ 21. Use a wire brush or plunger parts and adjusting bolt threads to remove caked-on dirt and corrosion.

☐ 22. Inspect plunger seals and gaskets for tears and cuts; replace if necessary.

## Job Sheet 4

☐ 23. Coat all plunger bores with a high temperature waterproof grease.

**Caution: Do not inter-mix wedge and plunger assembly components.**

☐ 24. Check anchor plungers for markings. "L" plunger is installed on left hand brake and "R" plunger is installed on right hand brake.

☐ 25. Coat entire anchor plunger with grease and install into plunger bore, making sure plunger seats on bosses at the bottom.

☐ 26. Install plunger seal without damaging the seal assembly.

☐ 27. Apply film of grease to shoe rest pads, plunger, and bolt slots.

☐ 28. Install new or relined brake shoes.

☐ 29. Install brake shoe return springs.

☐ 30. Measure and compare brake shoe to drum diameter making sure drums will go over shoes.

☐ 31. Install new or reconditioned brake drum.

☐ 32. Install tire and wheel assemblies and adjust wheel bearings.

☐ 33. Adjust brake shoe clearance. Refer to service manual for correct procedure.

☐ 34. Remove safety stands and lower vehicle.

☐ 35. Start the engine and change the air system.

☐ 36. Uncage the spring brake chambers. Follow all safety precautions.

☐ 37. Check brake operation.

☐ 38. Set parking brake and remove the wheel blocks.

☐ 39. Record work on job ticket.

☐ 40. Turn in job ticket when finished.

☐ 41. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________________________

______________________________________________

______________________________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| TOTAL PARTS/MATERIALS | | | |

## SPECIFICATIONS CHECKED

| | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |

School/Work Name ____________________

Address ____________________

Phone # ____________________

Date In ____________

Date Out ____________

## JOB TICKET

Customer Name ____________________

Customer Address ____________________

Customer Phone # ____________________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ____________________

____________________

Services/repairs made: ____________________

| | LABOR | |
|---|---|---|
| ____________________ | | |
| ____________________ | | |
| ____________________ | | |
| ____________________ | | |
| ____________________ | | |
| ____________________ | | |
| ____________________ | | |
| ____________________ | | |
| ____________________ | | |
| ____________________ | | |
| ____________________ | | |

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

____________________ Date ____________

Technician ____________

Supervisor ____________

Unit 1-C, Job Ticket for Job Sheet 4

DT:B-C-39

# Air Foundation Brakes
# Unit 1-C

## Job Sheet 5—Inspect, Clean, and Measure Brake Calipers, Pads, and Rotors; Replace Pads if Needed

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

| **Evaluation Criteria** | **Rating** |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Specifications are checked | ______ |
| Replacements/adjustments are made correctly | ______ |
| Job ticket is filled out properly | ______ |
| Cleanup is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Jack and safety stands
6. Wet type brake parts cleaner
7. Metallic-based, temperature-resistant antiseize compound
8. Lubricant
9. Air brake system to be worked on
10. Others—as recommended by instructor and service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Move vehicle into shop.

☐ 4. Apply the parking brake.

☐ 5. Block the vehicle wheels.

☐ 6. Raise the vehicle and support with safety stands.

## Job Sheet 5

☐ 7. If equipped with spring brakes, release spring brakes with air pressure; then manually cage spring brake. Follow all safety precautions.

☐ 8. Remove wheel assembly.

☐ 9. Fully back off slack adjuster. On automatic slack adjusters remove lock clip. Using a wrench, turn manual adjusting nut end of worm gear clockwise until brake piston assembly is fully retracted.

☐ 10. Remove caliper hardware to remove shoe and lining assembly. Follow procedure in service manual.

☐ 11. Slide caliper to full outboard position; then remove brake shoe and lining assembly.

☐ 12. Clean and inspect caliper, remove any rust, and check bushings for wear and lubricant.

☐ 13. Inspect brake lining for uneven wear on both linings, cracks, and excessive temperature.

☐ 14. Inspect and measure rotor. Check rotor for cracks and scores that may be due to excessive operating temperature. Severe overheating is a bluish color to rotor's metal surface.

☐ 15. Check with instructor if rotor needs to be replaced.

☐ 16. Record findings on job ticket.

☐ 17. Coat caliper guide pin and retainer with a metallic-based, temperature-resistant antiseize compound.

☐ 18. Install new brake pads in caliper assembly.

☐ 19. Install caliper hardware that supports shoe and lining assembly.

☐ 20. Make sure that caliper assembly moves freely for proper brake operation.

☐ 21. After installation is complete, lubricate caliper housing and slack adjuster.

☐ 22. Adjust brakes. Refer to service manual for correct procedure.

☐ 23. Install wheel assembly.

☐ 24. Uncage spring brake. Follow safety precautions.

☐ 25. Remove safety stands and lower vehicle.

☐ 26. Check for proper brake operation.

## Job Sheet 5

☐ 27. Set parking brake and remove the wheel blocks.

☐ 28. Record work on job ticket.

☐ 29. Turn in job ticket when finished.

☐ 30. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

______________________________

______________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE | |
|---|---|---|---|
| | | | |
| TOTAL PARTS/MATERIALS | | | |

## SPECIFICATIONS CHECKED

| | |
|---|---|
| | |

School/Work Name ____________________

Address ____________________

Phone # ____________________

Date In ____________

Date Out ____________

## JOB TICKET

Customer Name ____________________

Customer Address ____________________

Customer Phone # ____________________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ____________________

Services/repairs made: ____________________

| LABOR | |
|---|---|
| | |

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

____________________ Date ____________

Technician ____________

Supervisor ____________

Unit 1-C, Job Ticket for Job Sheet 5

DT:B-C-45

# Air Supply System
# Unit 2-C

## Objective Sheet

### Unit Objective

After completing this unit, the student should be able to service the air supply system and its components. The student should demonstrate these competencies by completing the assignment sheet and job sheets and by scoring a minimum of 85 percent on the written test.

### Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to the air supply system with their definitions.
2. Identify the components of the air supply system.
3. Match air supply components with their basic functions.
4. Label the main parts of a compressor.
5. Complete statements concerning the characteristics of compressors.
6. Select true statements concerning the loading and unloading process.
7. Complete statements concerning the characteristics of governors.
8. Distinguish among the methods of providing clean air to the compressor.
9. Identify the parts and ports of an air dryer.
10. Complete statements concerning the characteristics of air dryers.
11. Distinguish between the cycles that occur in the operation of the air dryer.
12. Distinguish between optional devices that may be used on supply systems.
13. Complete statements concerning the characteristics of supply reservoirs.
14. Identify valves and switches used on the air supply system.
15. Match supply system valves and switches with their functions.
16. Complete statements concerning the basic characteristics of air brake valves.
17. Complete statements concerning the types of lines used on the air supply system.
18. Identify and connect components in an air supply system. (Assignment Sheet 1)
19. Service the reservoir and check valve function, build-up time, and cut-out pressure. (Job Sheet 1)

## Objective Sheet

20. Inspect and service belt-driven compressor and associated lines. (Job Sheet 2)

21. Inspect, service, and time gear-driven compressor, valves, and associated lines. (Job Sheet 3)

22. Inspect and service air dryer system; repair or replace as needed. (Job Sheet 4)

# Air Supply System
# Unit 2-C

## Information Sheet

1. **Terms and definitions**

    a. **Build-up time**—Period required for the air compressor to fully pressurize the air brake system

    b. **Charge**—To load or fill to capacity; to bring an air system up to its operational pressure

    c. **Compressor output**—Rate at which a compressor produces pressurized air; usually measured as air flow in cubic feet per minute (cfm)

    d. **Cut-in pressure**—Pressure level in the air system supply reservoir that triggers the compressor load cycle

    e. **Cut-out pressure**—Pressure level in the air system supply reservoir that triggers the compressor unload cycle

    f. **Desiccant**—Granular substance used to remove moisture from the air stream flowing through the air dryer

    g. **Integral**—Formed as a unit with another part

    h. **Load cycle**—Time during which the air compressor is building air pressure in the air system

    i. **Particulate**—Small solid contaminant such as dust and road grit

    j. **Purge**—Initial blast of air (decompression) from the air dryer purge valve at the beginning of the unload cycle of the air compressor

    k. **Regeneration**—Backflow of air from the air system and through the air dryer to remove moisture and to ready the air dryer for the next compressor load cycle

    l. **Remote**—One part operating at some distance removed from the other part(s)

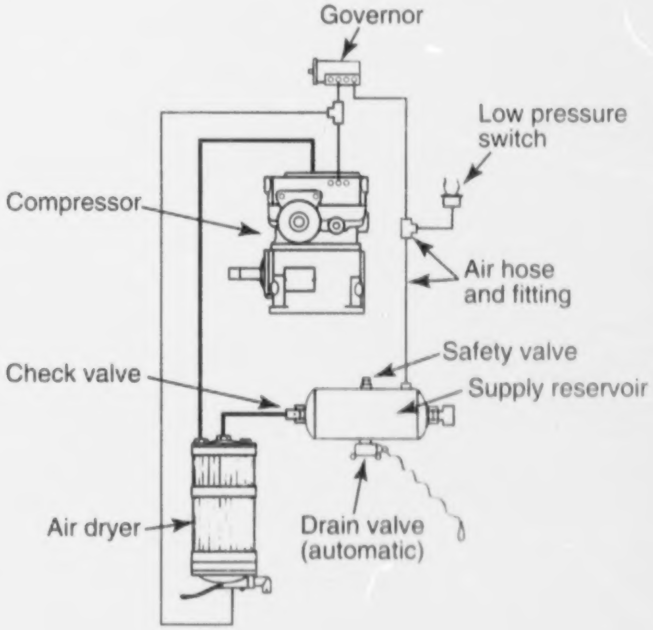
    m. **Sump**—Pit or reservoir serving as a drain or receptacle for liquids

    n. **Unload cycle**—Time during which the air compressor is idling and is not building air pressure in the air system

    o. **Valve**—Mechanical device that starts, stops, or regulates the flow of fluid products (air or liquid)

## 2. Components of the air supply system

Figure 1


Governor
Low pressure switch
Compressor
Air hose and fitting
Safety valve
Check valve
Supply reservoir
Air dryer
Drain valve (automatic)

Courtesy of Haldex Midland Services

## 3. Basic functions of the air supply components

a. **Compressor**—Pumps air to and builds air pressure in an air system

b. **Governor**—Controls operation of the compressor so that air pressure is maintained between a maximum and minimum pressure level; also controls operation of air dryer

c. **Air dryer**—Cools, filters, and removes moisture, oil, and other contaminants from the air delivered by the compressor

d. **Supply reservoir**—Holds pressurized air for transfer to the service reservoirs

e. **Valves and switches**—Direct, control, and monitor various qualities of the air in the supply system such as pressure level and flow direction

f. **Air brake lines and fittings**—Connect brake components so air is not lost from system

## Information Sheet

### 4. Parts of a compressor

a. **Cylinder head**—Iron casting that houses the inlet, discharge, and unloader valving

b. **Crankcase**—Houses the cylinder bores, pistons, crankshaft and main bearings, and mounting surface

Figure 2—Exterior view

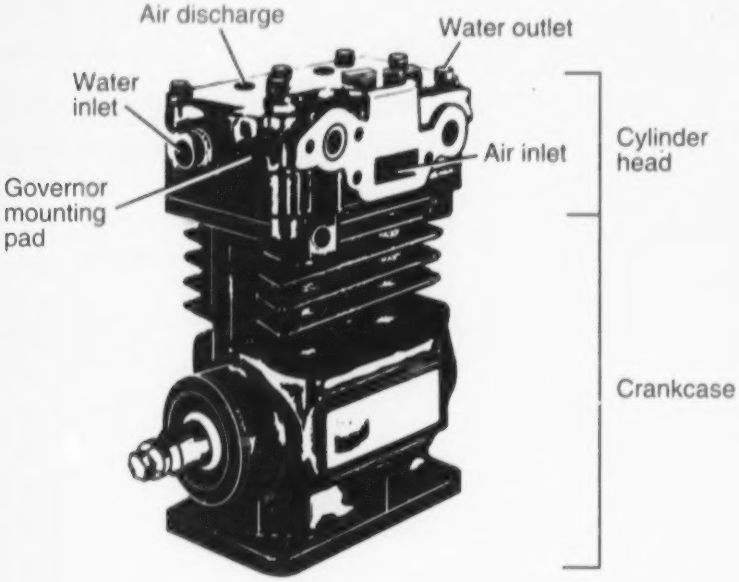

Air discharge
Water outlet
Water inlet
Governor mounting pad
Air inlet
Cylinder head
Crankcase

Figure 3—Cross section view

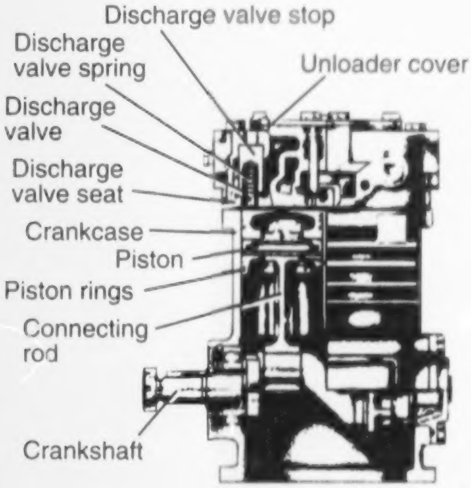
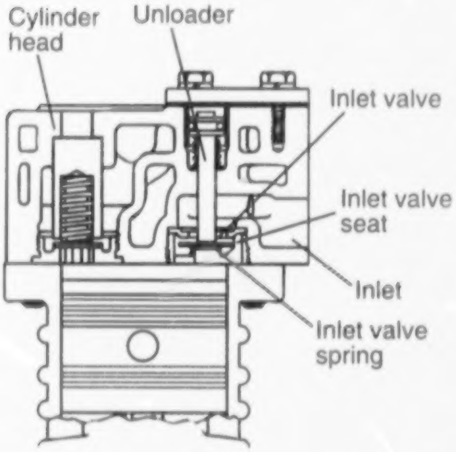

Discharge valve stop
Discharge valve spring
Unloader cover
Discharge valve
Discharge valve seat
Crankcase
Piston
Piston rings
Connecting rod
Crankshaft

Figure 4—End view of cylinder head


Cylinder head
Unloader
Inlet valve
Inlet valve seat
Inlet
Inlet valve spring

Courtesy of AlliedSignal Bendix

## Information Sheet

### 5. Characteristics of compressors

a. Supply and maintain pressurized (compressed) air to the air brake system and/or auxiliary air systems

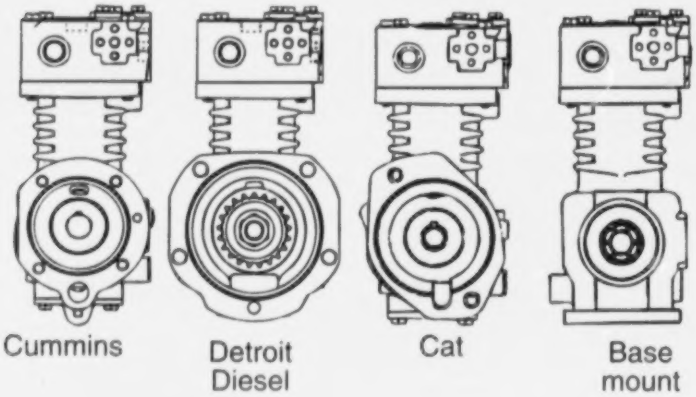
b. Are driven by the vehicle's engine using a belt (medium-duty) or a gear (heavy-duty)

c. Operate continuously while the engine is running, but only compress air when actuated by the governor

d. Typically use the vehicle's lubrication and cooling systems, but large units may also have self-lubrication mechanisms and combination water and air cooling systems.

e. May be base mounted or flange mounted with various flange configurations for different vehicle engine designs

Figure 5



Courtesy of AlliedSignal Bendix

### 6. Loading and unloading process

a. Loading **(intake and compression of air)**

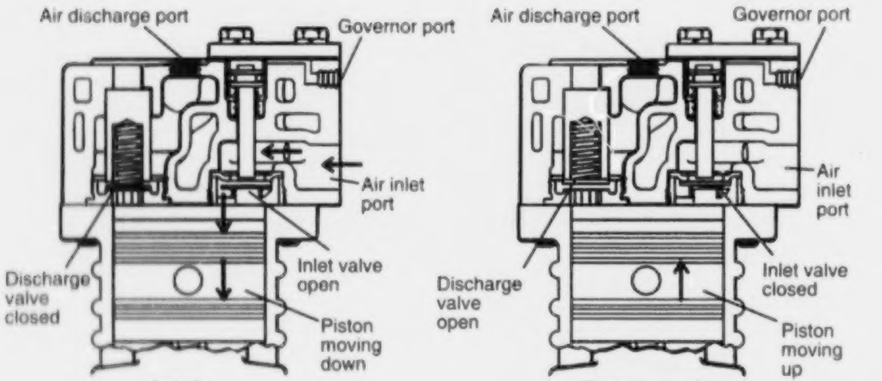
1) During the down stroke of the piston, the inlet valve opens and atmospheric air is drawn into the cylinder.

2) As the piston begins its upward stroke, the air that was drawn into the cylinder is being compressed.

3) Then the inlet valve closes and the discharge valve opens which allows air to flow into the discharge line and to the reservoirs.

4) As the piston starts down, the discharge valve closes which prevents the compressed air from returning.

Figure 6—Loaded


Air discharge port
Governor port
Air inlet port
Discharge valve closed
Inlet valve open
Piston moving down
Air discharge port
Governor port
Air inlet port
Discharge valve open
Inlet valve closed
Piston moving up

Intake

Compression

Courtesy of AlliedSignal Bendix

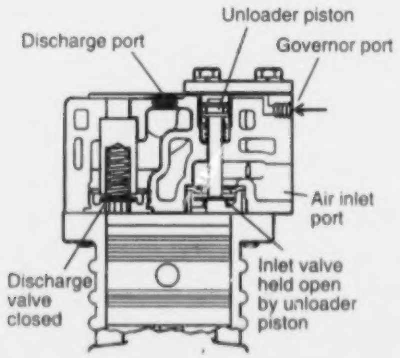
b. Unloading **(non-compression of air)**

1) When air pressure in the reservoir reaches the cut-out setting of the governor, the governor allows air to pass from the reservoir, through the governor, and into the cavity above the unloader pistons.

2) As the unloader pistons move down and hold the inlet valves off their seats, air is pumped back and forth between the two cylinders, and the discharge valves remain closed.

3) When air pressure from the reservoir drops to the cut-in setting of the governor, the governor closes and exhausts the air from above the unloader pistons. The unloader springs force the pistons upward and the inlet valves return to their seats. Compression can then resume.

Figure 7—Unloaded


Unloader piston
Discharge port
Governor port
Air inlet port
Discharge valve closed
Inlet valve held open by unloader piston

Courtesy of AlliedSignal Bendix

## Information Sheet

### 7. Characteristics of governors

a. Constantly monitor the air pressure in the supply reservoir and automatically control the operation of the air compressor

b. Initiate the compressor load cycle when cut-in pressure is realized, and initiate the compressor unload cycle when the cut-out pressure is reached

c. Also control the air dryer by sending an air signal (at the beginning of the compressor unload cycle) to the control port of the air dryer, initiating the purge cycle; when this air signal is removed by the governor (at the beginning of the compressor load cycle), the purge valve closes and the drying cycle begins

d. May be remote mounted or direct flange mounted on the compressor

### 8. Methods of providing clean air to the compressor

a. **Naturally aspirated**—Compressor uses its own attached air strainer which is typically made of polyurethane sponge or pleated paper dry element.

b. **Naturally aspirated**—Compressor inlet is connected to the engine air cleaner or the vacuum side of the supercharger or turbocharger.

c. **Pressurized induction**—Compressor inlet is connected to the pressure side of the supercharger or turbocharger.

### 9. Parts and ports of an air dryer (desiccant type)

a. **Upper housing**—Includes outer shell, inner desiccant cartridge, oil separator, and brackets

b. **Lower base assembly**—Includes check valve, safety valve, purge valve, sump, and threaded air connections (ports)

    1) Control port—Purge valve control and turbo cut-off

    2) Supply port—Air inlet

    3) Delivery port—Air outlet

Figure 8—Exterior view

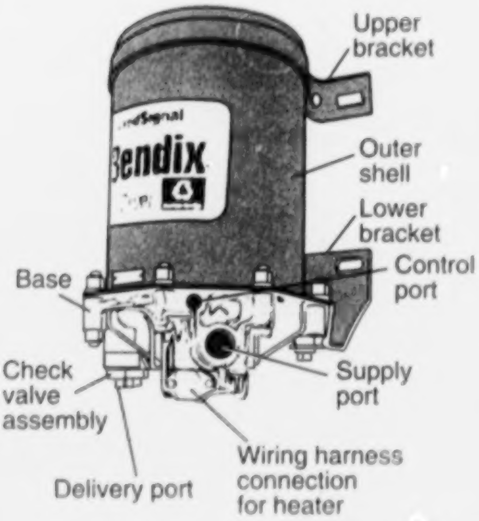
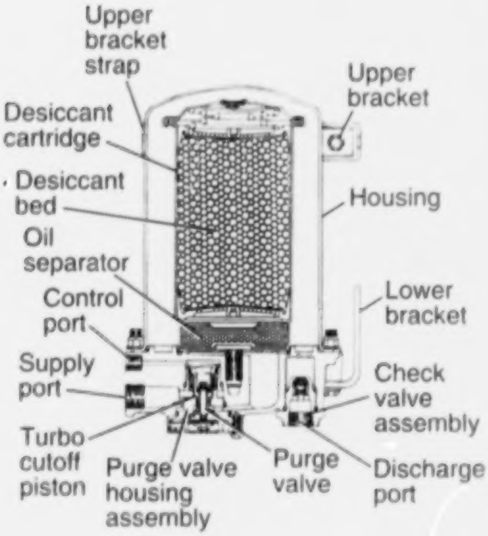

Upper bracket
Outer shell
Lower bracket
Control port
Base
Check valve assembly
Supply port
Delivery port
Wiring harness connection for heater
Bendix

Figure 9—Cross section view


Upper bracket strap
Upper bracket
Desiccant cartridge
Desiccant bed
Housing
Oil separator
Control port
Lower bracket
Supply port
Check valve assembly
Turbo cutoff piston
Purge valve housing assembly
Purge valve
Discharge port

Courtesy of AlliedSignal Bendix

## 10. Characteristics of air dryers

a. Provide clean, dry air to reservoirs, valves, and other components

b. Common designs include:

   1) **Desiccant type**—Uses a replaceable desiccant cartridge to remove water vapor from the pressurized air; also has an oil separator and may have additional filters depending on the model

   2) **Heat exchanger type**—Uses external fins for cooling and condensing the pressurized air; also has a wire filter for removing microscopic carbon and other particulates from the air

c. Many designs also include a replaceable heater and thermostat assembly to prevent freezing of the accumulated condensate prior to its exhaust.

d. Extended purge models are available for applications where heavy air usage is the norm such as city buses.

## 11. Cycles that occur in the operation of the air dryer

a. **Drying cycle**—When air system reaches governor cut-in setting, the compressor is loaded (compressing air), and the air dryer operates in the drying cycle.

1) Compressed air, oil, water, and vapors enter the supply port.

2) As air travels through the base, air temperature is reduced, vapors condense, and liquids drop to the bottom or sump of the air dryer base.

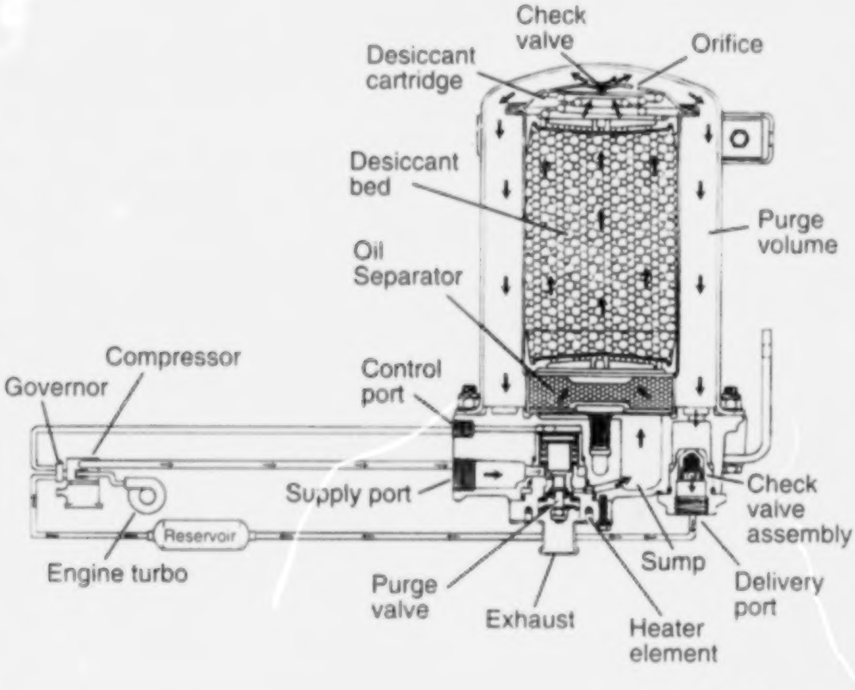
3) Air enters oil separator where water, oil, vapors, and solid contaminants are removed.

4) Air enters desiccant drying bed. Air becomes progressively drier as water vapor adheres to the desiccant material.

5) Dry air exits desiccant cartridge through check valve or orifice to enter purge volume area.

6) Dry air flows through check valve and out the delivery port to supply reservoir.

Figure 10—Drying cycle


Check valve
Desiccant cartridge
Orifice
Desiccant bed
Purge volume
Oil Separator
Compressor
Governor
Control port
Supply port
Check valve assembly
Reservoir
Engine turbo
Sump
Delivery port
Purge valve
Exhaust
Heater element

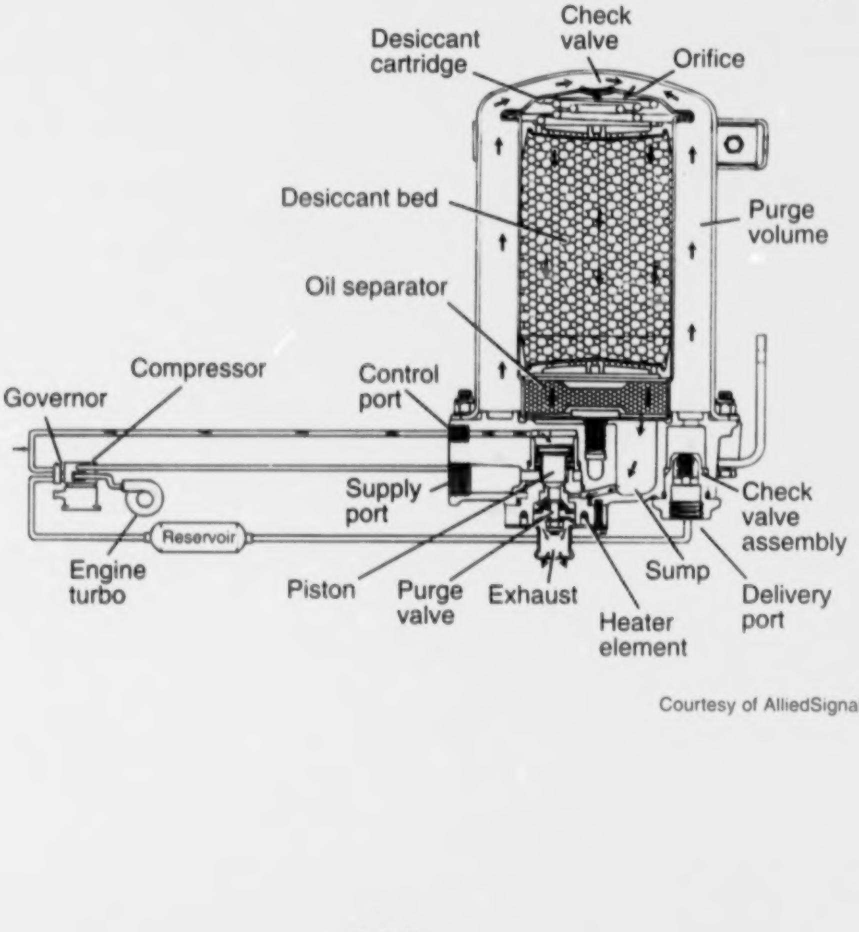
Courtesy of AlliedSignal Bendix

## Information Sheet

b. **Purge cycle**—When air system reaches governor cut-out setting, the compressor unloads (air compression stops), and the air dryer begins the purge cycle.

1) Purge piston moves, causing purge valve to open to atmosphere and partially closing off the air supply from the compressor.
2) Contaminants in the base sump are expelled immediately when the purge valve opens.
3) Air flowing through the desiccant cartridge changes direction and begins to flow toward the open purge valve.
4) Oil and solid contaminants in the oil separator flow out the purge valve.
5) Purge valve closes when air pressure is reduced and governor signals the compressor to charge.

Figure 11—Purge cycle


Check valve
Desiccant cartridge
Orifice
Desiccant bed
Purge volume
Oil separator
Compressor
Governor
Control port
Supply port
Reservoir
Engine turbo
Piston
Purge valve
Exhaust
Heater element
Sump
Check valve assembly
Delivery port

Courtesy of AlliedSignal Bendix

12. **Optional devices that may be used on supply systems**

    a. **Alcohol evaporator**

        1) May be used on some systems that do not have an air dryer

        2) Is installed in the compressor discharge line between the compressor and the supply reservoir

        3) Operates by injecting alcohol mist into the air flow to reduce the risk of freeze-up by lowering the freezing temperature of water

    b. **Aftercooler**

        1) May be used on some systems that do not have an air dryer

        2) Is installed between the compressor and the supply reservoir

        3) Condenses and eliminates water from pressurized (compressed) air

13. **Characteristics of supply reservoirs**

    a. Hold pressurized and conditioned air (heated and dried)

    b. As the air in the reservoir cools, water and contaminants collect in the reservoir.

    c. This water must be drained at least once a day, unless the vehicle is equipped with an automatic drain valve which operates each time the brakes are applied.

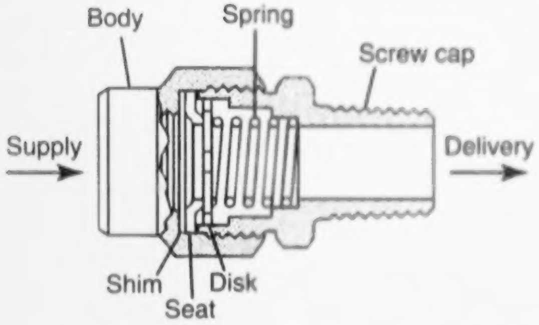
    d. The supply reservoir is the first tank after the compressor.

    e. The supply reservoir is sometimes called the "wet tank" because it is where water and oil are most likely to accumulate, especially in systems without a functional air dryer.

14. **Valves and switches used on the air supply system**

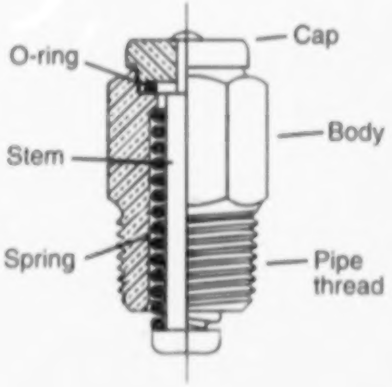
    a. **Single check valve** (one way)

    Figure 12



    b. **Safety valve** (pressure relief)

    Figure 13



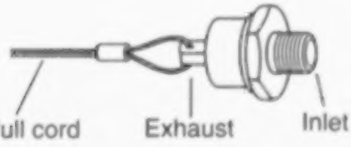
Courtesy of Freightliner Corporation

## Information Sheet

c. **Drain valve**

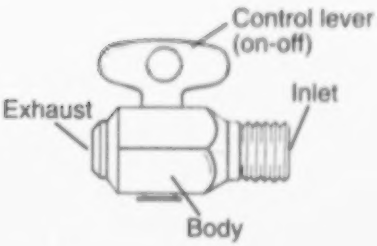
1) Manual—Pull chain

Figure 14


Pull cord
Exhaust
Inlet

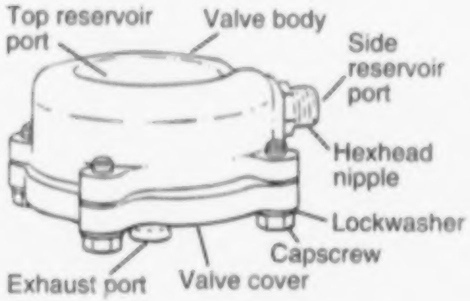
2) Manual—Drain cock

Figure 15


Control lever (on-off)
Exhaust
Inlet
Body

3) Automatic drain valve

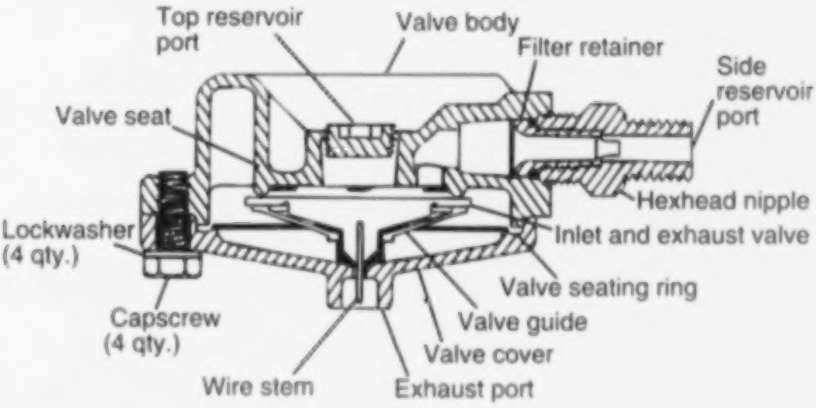
Figure 16—Exterior view


Top reservoir port
Valve body
Side reservoir port
Hexhead nipple
Lockwasher
Capscrew
Exhaust port
Valve cover

Courtesy of Freightliner Corporation

## Information Sheet

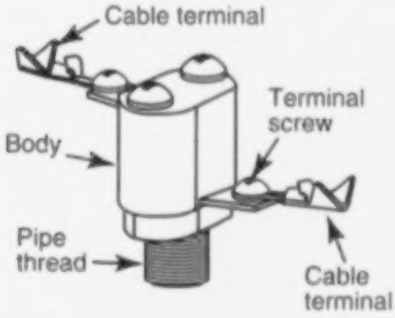
Figure 17—Cross section view


Top reservoir port
Valve body
Filter retainer
Side reservoir port
Valve seat
Hexhead nipple
Lockwasher (4 qty.)
Inlet and exhaust valve
Valve seating ring
Capscrew (4 qty.)
Valve guide
Valve cover
Wire stem
Exhaust port

Courtesy of Freightliner Corporation

d. **Low pressure switch** (double terminal shown)

Figure 18


Cable terminal
Terminal screw
Body
Pipe thread
Cable terminal

15. **Functions of supply system valves and switches**

a. **Single check valve (one-way)**—Allows air to flow in only one direction (from air dryer to supply reservoir)

b. **Safety valve**—Releases air at excessive pressures; "pops off" when limit is reached

c. **Drain valve**—Permits removal of condensate from reservoir; may be manual or automatic; may also be electrically heated to prevent valve from freezing open or closed

Note: Automatic drain valves are often referred to as spitter valves.

d. **Low pressure switch**—Senses pressure in reservoir and actuates an in-cab buzzer and warning light when pressure falls below a specified level (typically 60 psi)

## Information Sheet

### 16. Basic characteristics of air brake valves

- a. All air brake valves have:
  - 1) Air passages
  - 2) Internal moving parts
- b. As the valve's internal parts move, they direct the compressed air to the desired location.
- c. Each air valve has at least:
  - 1) One supply port to allow air to enter the valve
  - 2) One delivery port to allow air to exit the valve

    Note: Many valves have more than one supply and/or delivery ports.
- d. Some air valves may have:
  - 1) Control port that allows an air pressure source to control when air can flow through the valve
  - 2) Exhaust port that allows air to vent to the atmosphere
- e. Some valves have special function control ports such as balance or reservoir ports.
- f. Air brake valves operate either manually or automatically.
  - 1) Manual valves require the driver to move a knob, handle, or pedal to work the valve.
  - 2) Automatic valves use control ports or internal regulating parts to work.

### 17. Types of lines used on the air supply system

- a. **Reinforced hose**
  - 1) Commonly made of fabric and rubber; may be lined with Teflon or covered with steel braid
    - a) Hose with fabric braided exterior has replaceable ends.
    - b) Hose with rubber coated exterior has non-replaceable ends.
  - 2) Typically used where mere flexibility is needed such as when going to the air brake chambers or for trailer connections
- b. **Metal tubing**
  - 1) Used for high heat applications
  - 2) Commonly found between the compressor and the next component (dryer or supply reservoir)
  - 3) Require compression fittings

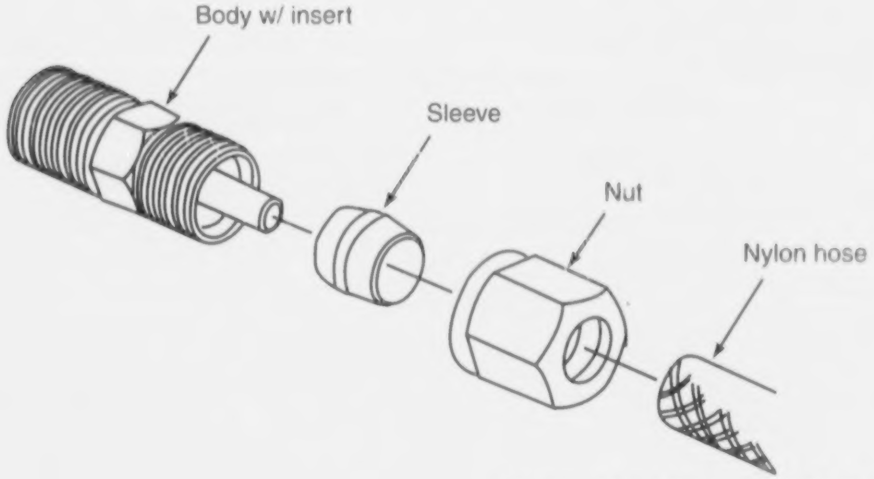
c. **Nylon tubing**

1) Commonly used for standard service and supply lines to connect components throughout the system

2) Should not be used in high heat areas

3) Use special fittings designed for nylon tubing

Figure 19



Courtesy of Peterbilt Motors Co./PACCAR Inc.

4) May be color coded for system identification:

   a) Black—Accessory equipment

   b) Blue—Front system

   c) Green—Rear system

   d) Red—Parking system

   e) Yellow—Trailer system

   f) Blue—Trailer supply

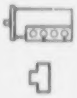
# Air Supply System
## Unit 2-C

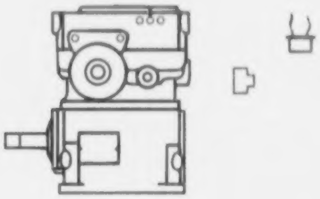
### Assignment Sheet 1—Identify and Connect Components in an Air Supply System

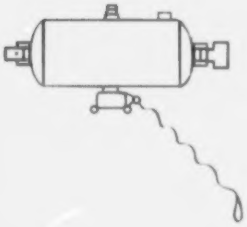
Name ______________________________ Overall Rating ____________

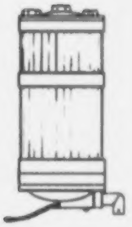
| Evaluation Criteria | Rating |
|---|---|
| Components are correctly identified | ______ |
| Components are correctly connected | ______ |

Directions: Shown below are the components that make up the air supply system. Identify each component and then draw lines that connect the components in the correct manner.









Courtesy of Haldex Midland Services

# Air Supply System
# Unit 2-C

## Job Sheet 1—Service the Reservoir and Check Valve Function, Build-Up Time, and Cut-Out Pressure

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

| **Evaluation Criteria** | **Rating** |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Specifications are checked | ______ |
| Adjustments/repairs/replacements are made correctly | ______ |
| Job ticket is filled out properly | ______ |
| Cleanup is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Stop watch
6. Air brake system to be worked on
7. Others—as recommended by instructor and equipment service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Move vehicle into shop.

☐ 4. Apply the parking brakes.

☐ 5. Block the vehicle wheels.

☐ 6. Drain supply reservoir (wet tank). During draining, inspect air for excess oil and water.

☐ 7. Observe the service reservoir air pressure gauges located in the cab. If pressure is low (less than 60psi), start engine and charge the air system.

## Job Sheet 1

☐ 8. Observe gauges to see if check valves on front brake (secondary) service reservoir and rear brake (primary) service reservoir actually function.

☐ 9. Drain rear brake service reservoir.

☐ 10. Check to see that gauge registers front brake service reservoir pressure as full to prove that double check valve is functional.

☐ 11. Drain front brake service reservoir.

☐ 12. Close drain cocks on all tanks.

☐ 13. Check air system build-up time:

  ☐ a. Start engine and run at governed speed.

  ☐ b. With a stop watch check the time it takes to increase air pressure from 85 psi to 100 psi. It should take approximately 25 seconds.

☐ 14. Note pressure at which low pressure warning device deactuates. This should be 60 psi ± 10%.

☐ 15. Check governor cut-out pressure. This should be 125 psi maximum with 17–22 psi range.

☐ 16. Adjust governor cut-out if necessary by loosening lock nut and turning screw located on top of governor.

☐ 17. Record findings on job ticket.

☐ 18. Turn in job ticket when finished.

☐ 19. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

______________________________

______________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| TOTAL PARTS/MATERIALS | | | |

## SPECIFICATIONS CHECKED

| | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |

School/Work Name ______________________

Address ______________________

Phone # ______________________

Date In ____________

Date Out ____________

## JOB TICKET

Customer Name ______________________

Customer Address ______________________

Customer Phone # ______________________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ______________________

______________________

Services/repairs made: ______________________

| LABOR | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

______________________ Date ____________

Technician ____________

Supervisor ____________

Unit 2-C, Job Ticket for Job Sheet 1

DT:B-C-67

# Air Supply System
# Unit 2-C

## Job Sheet 2—Inspect and Service Belt-Driven Compressor and Associated Lines

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

| **Evaluation Criteria** | **Rating** |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Specifications are checked | ______ |
| Adjustments/repairs/replacements are made correctly | ______ |
| Job ticket is filled out properly | ______ |
| Cleanup is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Belt tension gauge
6. Straight edge
7. Air brake system to be worked on
8. Others—as recommended by instructor and equipment service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Move vehicle into shop.

☐ 4. Apply the parking brakes.

☐ 5. Block the vehicle wheels.

☐ 6. Drain all air reservoirs.

☐ 7. Remove negative battery cable.

## Job Sheet 2

☐ 8. Remove air compressor drive belt.
  ☐ a. Loosen the air compressor bracket nut and bolt.
  ☐ b. Remove the air compressor adjustment bracket nut, washers, and bolts.
  ☐ c. Pivot the air compressor to remove all air compressor belt tension.
  ☐ d. Lift the air compressor belt from the air compressor pulley.
☐ 9. Inspect belt for cracks and wear; replace as needed.
☐ 10. Inspect air compressor pulley for wear or damage.
☐ 11. Inspect all brackets for wear or damage.
☐ 12. Inspect coolant hoses for leakage, wear, or damage.
☐ 13. Inspect air compressor discharge pipe and nut.
☐ 14. Inspect oil supply line and oil drain tube for damage.
☐ 15. Install air compressor belt.
☐ 16. Adjust air compressor belt and check belt tension with belt tension gauge.
☐ 17. Tighten air compressor adjusting bracket and bottom mounting bolts.
☐ 18. Check alignment of air compressor drive belt and pulleys with straight edge.
☐ 19. Install negative battery cable.
☐ 20. Start engine.
☐ 21. Charge air system, checking air compressor for leaks and operation.
☐ 22. Remove the wheel blocks.
☐ 23. Record findings on job ticket.
☐ 24. Turn in job ticket when finished.
☐ 25. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

______________________________

______________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| TOTAL PARTS/MATERIALS | | | |

**SPECIFICATIONS CHECKED**

| | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |

School/Work Name ______
Address ______
Phone # ______

Date In ______
Date Out ______

## JOB TICKET

Customer Name ______
Customer Address ______
Customer Phone # ______

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ______

Services/repairs made: ______

| LABOR | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

______ Date ______

Technician ______
Supervisor ______

Unit 2-C, Job Ticket for Job Sheet 2

DT:B-C-71

## Air Supply System
## Unit 2-C

### Job Sheet 3—Inspect, Service, and Time Gear-Driven Compressor, Valves, and Associated Lines

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

| Evaluation Criteria | Rating |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Specifications are checked | ______ |
| Adjustments/repairs/replacements are made correctly | ______ |
| Job ticket is filled out properly | ______ |
| Cleanup is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Dial indicator
6. Air brake system to be worked on
7. Others—as recommended by instructor and equipment service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Move vehicle into shop, apply the parking brakes, and block the vehicle wheels.

☐ 4. Drain all air reservoirs.

☐ 5. Remove negative battery cable.

☐ 6. Drain engine coolant, if equipped with a coolant-cooled compressor.

☐ 7. Remove any accessories that may be driven by the air compressor such as the fuel pump or power steering pump.

## Job Sheet 3

☐ 8. Remove air compressor discharge pipe.

☐ 9. Disconnect governor air line at the air compressor.

☐ 10. Disconnect water outlet hose at the air compressor.

☐ 11. Remove air compressor flange bolts and washers.

☐ 12. Remove air compressor bracket bolts and washers.

☐ 13. Remove air compressor from mounting flange.

☐ 14. Remove all gasket material from the sealing surfaces and clean compressor housing.

☐ 15. Inspect the air compressor crankshaft end clearance with dial indicator. Check service manual specifications for acceptable clearance.

☐ 16. Inspect the spline sleeve and coupling hub.

☐ 17. Service, clean, and repair unloader assembly.

☐ 18. Remove inlet elbow and discard gasket.

☐ 19. Insert suitable screwdriver blade under unloader spring and lift spring of saddle and remove saddle.

☐ 20. Lift each plunger guide and remove guide and plunger. Lift pistons out of bore.

☐ 21. Clean and inspect parts and install with new o-rings and gaskets.

☐ 22. Install inlet elbow with new gasket.

☐ 23. Install new gasket onto the air compressor flange.

☐ 24. Install air compressor and flange mounting bolts and washers. Check service manual for any special instructions such as air compressor timing.

☐ 25. Tighten air compressor flange bolts to correct torque.

☐ 26. Connect oil inlet hose, water hoses, and air intake hose and tighten.

☐ 27. Install any accessories (pumps) that may have been removed.

☐ 28. Fill the engine cooling system and check oil level.

☐ 29. Start and run engine.

## Job Sheet 3

☐ 30. Check for leaks and air compressor operation.

☐ 31. Remove the wheel blocks.

☐ 32. Record findings on job ticket.

☐ 33. Turn in job ticket when finished.

☐ 34. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE | |
|---|---|---|---|
| | | | |
| TOTAL PARTS/MATERIALS | | | |

**SPECIFICATIONS CHECKED**

| | |
|---|---|
| | |

School/Work Name ____________________
Address ____________________
Phone # ____________________

Date In ____________
Date Out ____________

## JOB TICKET

Customer Name ____________________
Customer Address ____________________
Customer Phone # ____________________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ____________________

Services/repairs made: ____________________

| LABOR | |
|---|---|
| | |

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

____________________ Date ____________

Technician ____________
Supervisor ____________

Unit 2-C, Job Ticket for Job Sheet 3

DT:B-C-77

# Air Supply System
# Unit 2-C

## Job Sheet 4—Inspect and Service Air Dryer System; Repair or Replace as Needed

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

| **Evaluation Criteria** | **Rating** |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Specifications are checked | ______ |
| Adjustments/repairs/replacements are made correctly | ______ |
| Job ticket is filled out properly | ______ |
| Cleanup is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Soap solution
6. Air brake system to be worked on
7. Others—as recommended by instructor and equipment service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Move vehicle into shop, apply the parking brakes, and block the vehicle wheels.

☐ 4. Drain all air tanks.

**Caution: Never connect or disconnect a hose or line containing compressed air.**

☐ 5. Test air brake dryer for leaks and correct operation.

☐ 6. Start the engine and charge the air system to the governor cut-out point.

## Job Sheet 4

☐ 7. Verify that any discharge of air occurs at the air dryer exhaust port. This is the air dryer purge cycle.

☐ 8. If the air dryer does not cycle properly, check for air leaks in the air dryer system.

☐ 9. Inspect tubing and hose for kinks or dents.

☐ 10. Check air tanks for excessive water.

☐ 11. Drain air tanks and remove air dryer from vehicle.

☐ 12. Mark the base (end cover) and the upper housing before separating.

☐ 13. Remove bolts and nuts to separate the base from the housing.

☐ 14. Separate the desiccant cartridge and sealing plate from the base.

☐ 15. Remove purge valve piston and clean and inspect.

☐ 16. Check thermostat and heater operation following the service manual procedure.

☐ 17. Clean and inspect all parts; replace as needed.

☐ 18. Assemble air dryer.

☐ 19. Install new o-rings and desiccant cartridge.

☐ 20. Lubricate the piston o-rings with an approved lubricant (barium-based).

☐ 21. Place the washer, diaphragm retainer, and purge valve onto the purge valve capscrew and torque to specifications.

☐ 22. Place the sealing ring on the bottom of the desiccant cartridge and attach the cartridge with four capscrews and lockwashers.

☐ 23. Place the desiccant cartridge and sealing plate assembly onto the cover and line up with the check valve.

☐ 24. Install bolts and tighten to correct torque.

☐ 25. Install the air dryer on the vehicle following the service manual procedure.

☐ 26. Check with your instructor before starting engine.

☐ 27. Start engine, charge up the air system to the governor cut-out point, and check operation.

☐ 28. Check and test for air leaks.

## Job Sheet 4

☐ 29. Remove the wheel blocks.

☐ 30. Record findings on job ticket.

☐ 31. Turn in job ticket when finished.

☐ 32. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

______________________________

______________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| TOTAL PARTS/MATERIALS | | | |

## SPECIFICATIONS CHECKED

| | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |

School/Work Name ____________________

Address ____________________

Phone # ____________________

Date In __________

Date Out __________

## JOB TICKET

Customer Name ____________________

Customer Address ____________________

Customer Phone # ____________________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ____________________

Services/repairs made: ____________________

| LABOR | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

____________________ Date __________

Technician __________

Supervisor __________

**Unit 2-C, Job Ticket for Job Sheet 4**

DT:B-C-83

# Air Service Circuits
## Unit 3-C

## Objective Sheet

### Unit Objective

After completing this unit, the student should be able to inspect and test appropriate service valves and circuits. The student should demonstrate these competencies by completing the assignment sheet and job sheets and by scoring a minimum of 85 percent on the written test.

### Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to the air service circuits with their definitions.
2. Compare the secondary and primary service circuits.
3. Identify the components of the secondary service circuit.
4. Identify the components of the primary service circuit.
5. Match service circuit components with their functions.
6. Identify the parts of a brake application valve and treadle assembly.
7. Complete statements concerning the characteristics of the brake application valve.
8. Identify the parts and ports of a quick release valve.
9. Identify the parts and ports of a relay valve.
10. Match other valves that may be used on service circuits with their descriptions.
11. Identify and connect components in the air service circuits. (Assignment Sheet 1)
12. Inspect and test brake application (foot) valve, fittings, and mounts; adjust or replace as needed. (Job Sheet 1)
13. Inspect and test stop light circuit switches, wiring, and connectors; repair or replace as needed. (Job Sheet 2)
14. Inspect and test relay valve; replace as needed. (Job Sheet 3)
15. Inspect and test quick release valve; replace as needed. (Job Sheet 4)

# Air Service Circuits
## Unit 3-C

### Information Sheet

1. **Terms and definitions**

   a. **Circuit**—Complete path of a system

   b. **Dual circuit**—Safety feature that prevents the total loss of braking in the event of a failure in one circuit

   c. **Modulate**—To adjust by graduations

   d. **Potentiometer**—Variable resistor that may be used to operate electronic components

   e. **Relay**—Device actuated by variations in conditions that in turn sends that message on to other devices in the same or different circuit

   f. **Treadle**—Swiveling or lever device operated by the foot that is used to apply the brakes

2. **Comparison of secondary and primary service circuits**

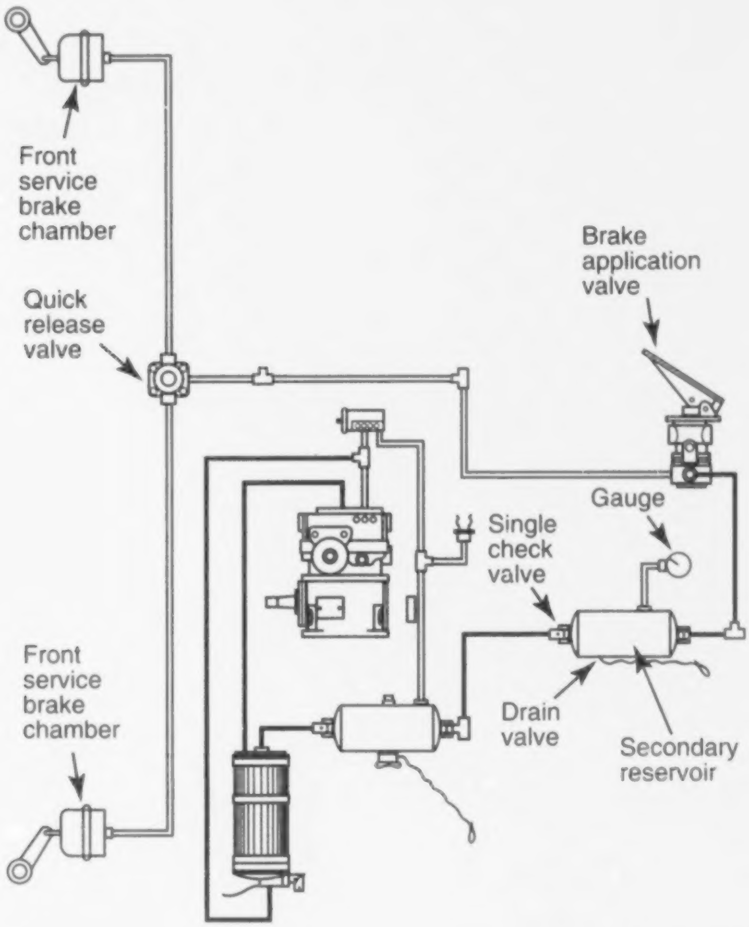
| DIFFERENCES | SIMILARITIES |
|---|---|
| Secondary service circuit serves the front brake service chambers.<br>Primary service circuit serves the rear brake service chambers.<br>Secondary service circuit uses a quick release valve.<br>Primary service circuit uses a relay valve.<br>Primary service circuit also includes the stop light switch and double check valve.<br>Each circuit uses a separate reservoir.<br>Reservoirs and air lines may be color-coded to distinguish between the two circuits.<br>Each circuit uses different supply and delivery ports on the brake application (foot) valve. | Both systems receive pressurized air from the supply reservoir.<br>Each reservoir is similar and requires a check valve, drain valve, and air pressure gauge to control and monitor its operation.<br>Both circuits are served by one brake application (foot) valve.<br>Either circuit can service the trailer. |

## Information Sheet

### 3. Components of the secondary service circuit

Note: Figure 1 builds on the air supply system shown and discussed in the previous unit with the new components making up the secondary service circuit now shown and identified.

Figure 1


Front service brake chamber
Brake application valve
Quick release valve
Gauge
Single check valve
Front service brake chamber
Drain valve
Secondary reservoir

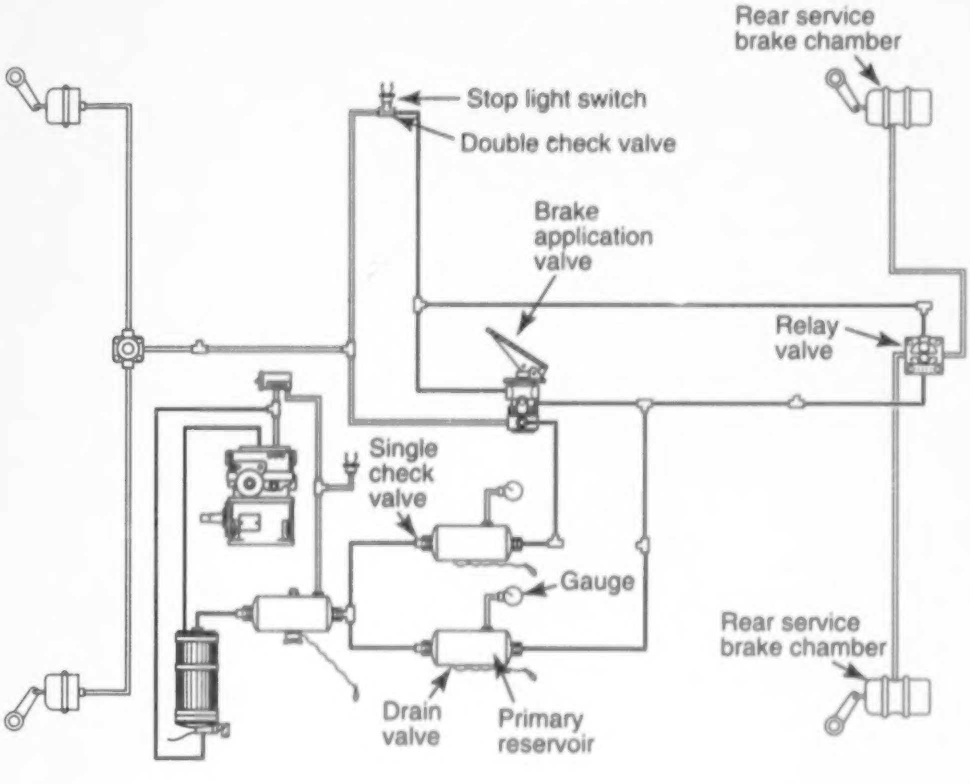
Courtesy of Haldex Midland Services

## Information Sheet

### 4. Components of the primary service circuit

Note: Figure 2 now shows the supply, secondary service, and primary service circuits with only the primary service components identified.

Figure 2


Rear service brake chamber
Stop light switch
Double check valve
Brake application valve
Relay valve
Single check valve
Gauge
Rear service brake chamber
Drain valve
Primary reservoir

Courtesy of Haldex Midland Services

### 5. Functions of service circuit components

a. **Service reservoirs (secondary and primary)**—Hold pressurized air from the supply system for use by the service systems (secondary and primary)

Note: Service reservoirs may also be referred to as dry tanks. FMVSS 121 requires that each service reservoir (secondary and primary) be isolated and separated from each other, as well as from the supply reservoir.

b. **Single (one-way) check valves**—Allow air to flow in only one direction (from supply reservoir to service reservoirs) and thereby prevent the backflow of air into the supply reservoir

c. **Drain valves**—Allow the draining of moisture and other contaminants from air reservoirs

d. **Air pressure gauges**—Indicate air pressure of service reservoirs; may be two separate gauges (secondary and primary) or two needle indicators on one gauge in the cab

e. **Brake application (foot) valve (dual circuit)**—Modulates the application of the service brakes by controlling the delivery of air to the service brake chambers; separates the primary and secondary service circuits so in case of a failure of one circuit, the other is still functional

f. **Quick release valve**—Allows faster exhaustion of air from front service chambers

g. **Service brake chambers (front and rear)**—Convert air pressure to mechanical force that is used to apply the foundation brakes

Note: Rear brake chamber units have both a service brake chamber and a spring brake chamber. The primary service circuit only serves the service brake part. The spring brake chamber is served by the parking brake and/or emergency brake circuits which will be covered in the next unit.

h. **Relay valve**—Functions as a remote relay station to speed up the application and release of the brakes; is mounted at the rear of the vehicle close to the chambers it serves

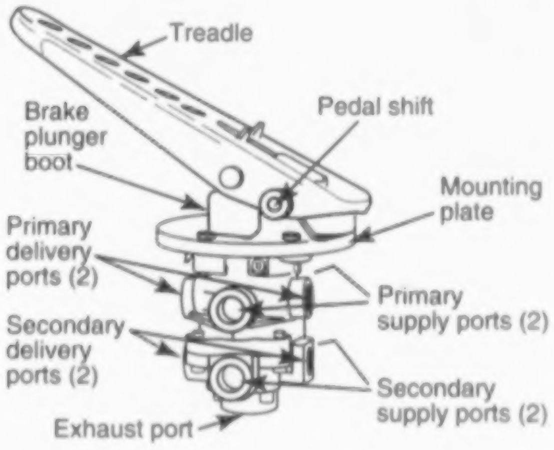
i. **Stop light switch**—Activates exterior brake lights when brakes are applied

j. **Double (two-way) check valve**—Seeks out the dominant air pressure from two sources and delivers it, as in this case to the stop light switch

6. **Parts of a brake application valve and treadle assembly**

a. Mechanical treadle and brake application valve (dual circuit)

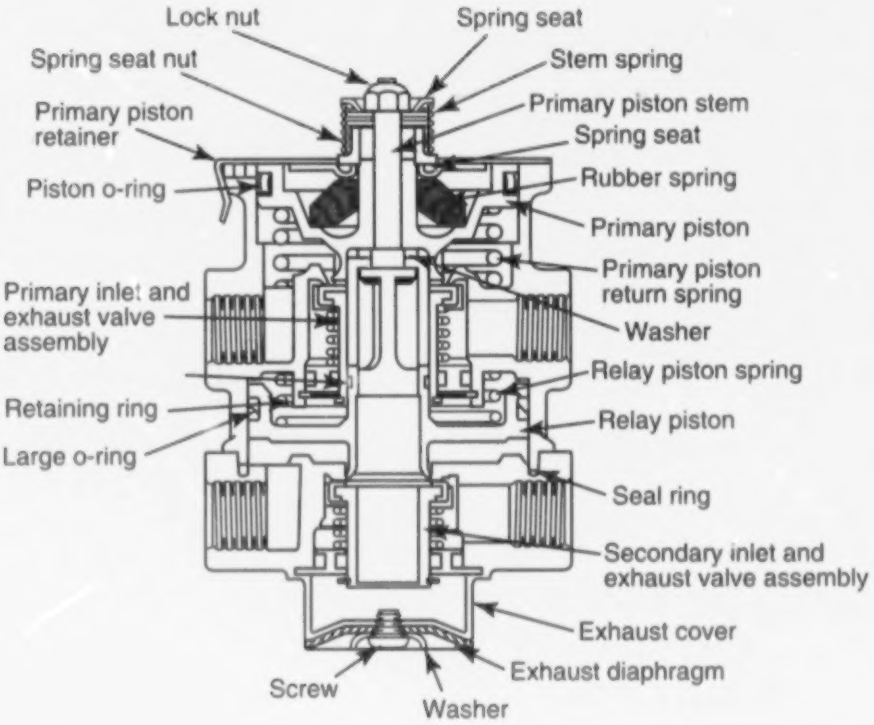
Figure 3—Exterior view



Courtesy of AlliedSignal Bendix

## Information Sheet

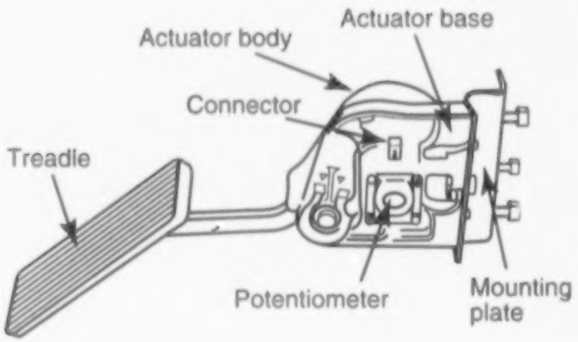
Figure 4—Cross section view


Lock nut
Spring seat
Spring seat nut
Stem spring
Primary piston stem
Primary piston retainer
Spring seat
Rubber spring
Piston o-ring
Primary piston
Primary piston return spring
Primary inlet and exhaust valve assembly
Washer
Relay piston spring
Retaining ring
Relay piston
Large o-ring
Seal ring
Secondary inlet and exhaust valve assembly
Exhaust cover
Exhaust diaphragm
Screw
Washer

Courtesy of AlliedSignal Bendix

b. Electronic treadle

Figure 5


Actuator base
Actuator body
Connector
Treadle
Potentiometer
Mounting plate

Courtesy of AlliedSignal Bendix

7. **Characteristics of the brake application valve**

   a. May be cab floor-mounted or engine firewall-mounted and suspended

   b. May be mechanically or electronically operated

      1) Mechanical brake application valves transmit mechanical force to the engine governor.

      2) Electronic treadles supply a variable electrical voltage to the engine's electronic controller.

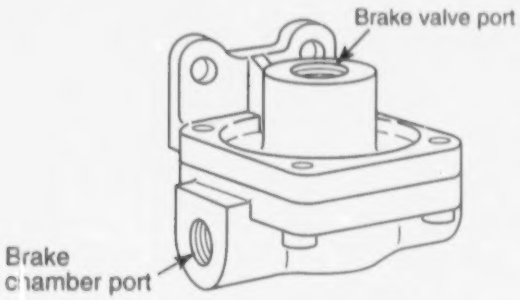
      Note: Electronic treadles are designed for electronically controlled diesel engines.

   c. Dual circuit valves use two separate supply and delivery circuits for primary and secondary braking.

   d. Single circuit valves may be seen on older equipment.

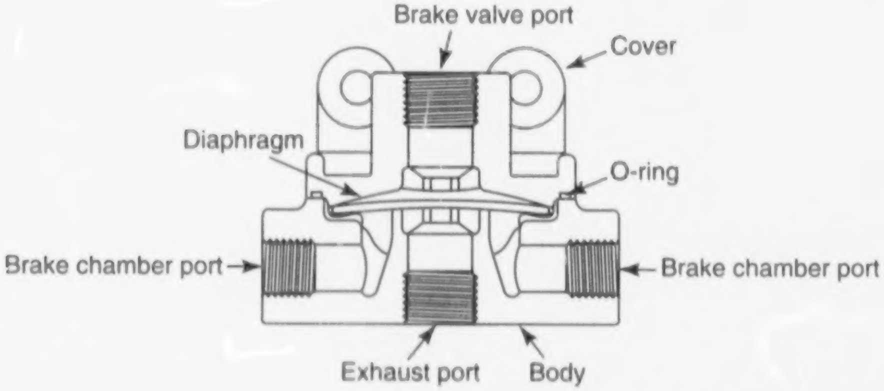
8. **Parts and ports of a quick release valve**

Figure 6—Exterior view


Brake valve port
Brake chamber port

Courtesy of AlliedSignal Bendix

Figure 7—Cross section view


Brake valve port
Cover
Diaphragm
O-ring
Brake chamber port
Brake chamber port
Exhaust port
Body

Courtesy of Freightliner Corporation

## Information Sheet

9. **Parts and ports of a relay valve**

Figure 8—Exterior view

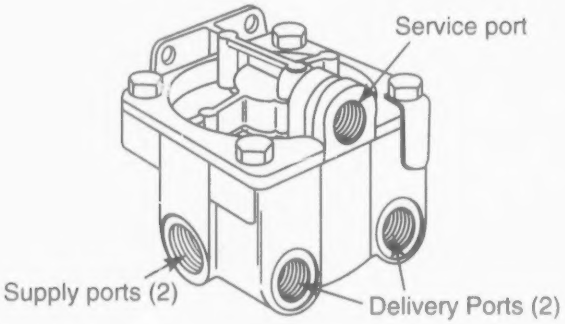
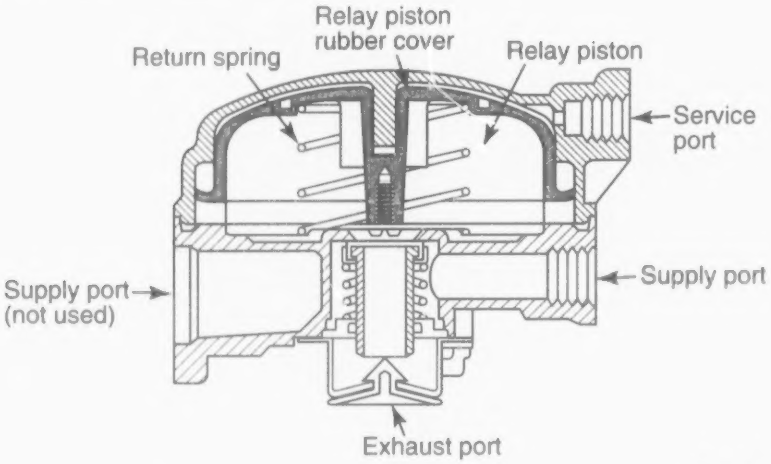

Service port
Supply ports (2)
Delivery Ports (2)

Figure 9—Cross section view


Relay piston rubber cover
Return spring
Relay piston
Service port
Supply port (not used)
Supply port
Exhaust port

Courtesy of Freightliner Corporation

10. **Other valves that may be used on service circuits**

    a. Front axle limiting (ratio) valve

        1) Automatically limits air pressure to the front service brake chambers

        2) Allows full front wheel braking only under extreme braking pressures

    b. Proportioning (bobtail) valve

        1) Reduces air pressure to the rear service brake chambers when the tractor is not towing a trailer

        2) Only used on tractor applications

    c. Pressure protection valve

        1) Protects the air supply to the brakes if a failure occurs in the accessory equipment

        2) Is used on vehicles with air accessories

# Air Service Circuits
## Unit 3-C

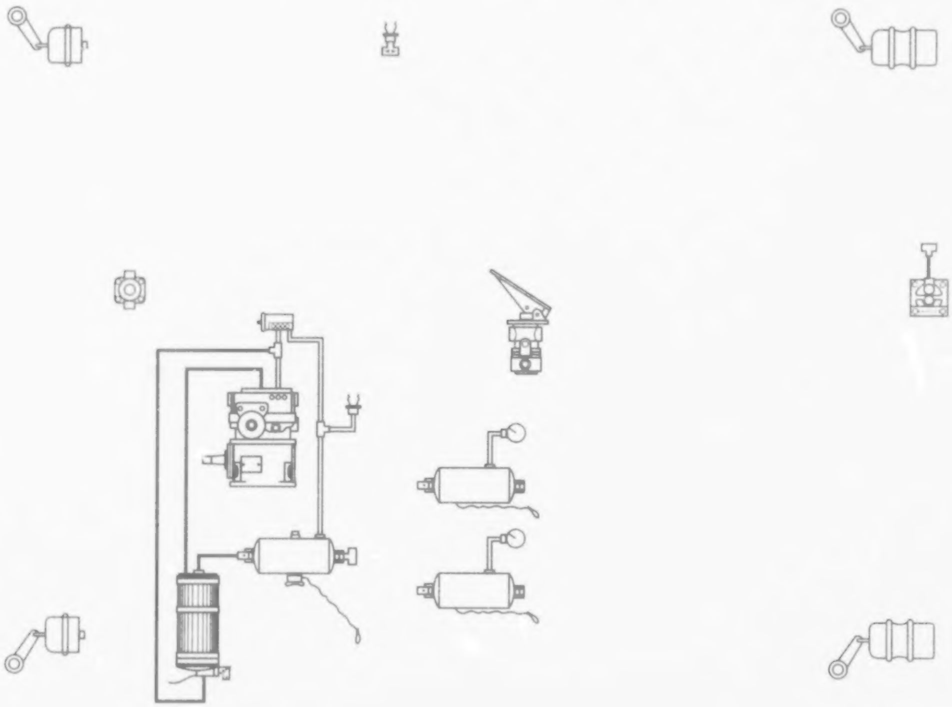
### Assignment Sheet 1—Identify and Connect Components in the Air Service Circuits

Name ______________________________ Overall Rating ______________

| Evaluation Criteria | Rating |
|---|---|
| Components are correctly identified | ______ |
| Components are correctly connected | ______ |

Directions: Shown below are the components that make up the air supply and service circuits. Identify each component and then draw lines that connect the components for the secondary circuit and the primary circuit. Use two different colors of ink or pencil to distinguish between the two service circuits.

Figure 1



Courtesy of Haldex Midland Services

# Air Service Circuits
# Unit 3-C

## Job Sheet 1—Inspect and Test Brake Application (Foot) Valve, Fittings, and Mounts; Adjust or Replace as Needed

Name ______________________________ Attempt Number ______________

Date ______________________________ Overall Rating ______________

| Evaluation Criteria | Rating |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Specifications are checked | ______ |
| Adjustments/repairs/replacements are made correctly | ______ |
| Job ticket is filled out properly | ______ |
| Cleanup is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Soap solution
6. Test (air) gauges
7. Air brake system to be worked on
8. Others—as recommended by instructor and equipment service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Move vehicle into shop, apply the parking brakes and block the vehicle wheels.

☐ 4. Check and inspect foot valve operation as follows.

  ☐ a. Connect test gauges to the primary and secondary delivery ports on the application valve.

  ☐ b. Release parking brakes and start the engine and build air pressure to 120 psi.

## Job Sheet 1

- ☐ c. Depress the pedal to several different positions; check the pressure on the test gauges to ensure that it varies equally and proportionately with the movement of the brake pedal.
- ☐ d. Fully depress the brake pedal, then release it. The reading on the test gauges should promptly fall to zero.
- ☐ e. Make and hold a pressure application of 80 psi and check the valve for leaks.
- ☐ f. Coat the exhaust port and body of the valve with a soap solution, and check for leakage. The leakage permitted is a one-inch bubble in 3 seconds.

☐ 5. If the brake valve does not function as described above, or if leakage is excessive, replace as follows.

- ☐ a. Drain all of the air reservoirs.
- ☐ b. Mark the brake valve air supply and delivery lines for assembly reference.
- ☐ c. Disconnect the air lines from the brake valve, and plug them to keep out contaminants.
- ☐ d. Remove capscrews from the mounting bracket.
- ☐ e. Remove the brake valve from mounting bracket.
- ☐ f. Note the locations and positions of the double check valves and elbows, then remove them from the brake valve. Clean dirt and old sealant from the threads.
- ☐ g. Make sure to replace the old valve with the same new one.
- ☐ h. Apply a small quantity of pipe sealant to the male threads of each of the double check valves and the elbows.
- ☐ i. Install the double check valves and elbows in the ports of the brake valves.
- ☐ j. Attach the brake valve and mounting bracket to the cab deck.
- ☐ k. Clean dirt, gravel, and other foreign material from the base of the brake pedal.
- ☐ l. Using a light oil, lubricate the brake pedal roller and roller pin.

## Job Sheet 1

- ☐ m. Install brake pedal; move the pedal as needed to align the hole in the brake pedal and the mounting bracket.
- ☐ n. Connect the air lines as previously marked. Tighten the nuts finger-tight. Using a wrench, further tighten the nuts.

☐ 6. Check with your instructor before starting the engine.

☐ 7. Start engine, charge up the air system, inspect for air leaks, and check brake operation.

☐ 8. Remove the wheel blocks.

☐ 9. Record findings on job ticket.

☐ 10. Turn in job ticket when finished.

☐ 11. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ____________________________________________

____________________________________________________________

____________________________________________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| TOTAL PARTS/MATERIALS | | | |

## SPECIFICATIONS CHECKED

| | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |

School/Work Name ______________________

Address ______________________

Phone # ______________________

Date In ____________

Date Out ____________

## JOB TICKET

Customer Name ______________________

Customer Address ______________________

Customer Phone # ______________________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ______________________

Services/repairs made: ______________________

| LABOR | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

______________________ Date ____________

Technician ____________

Supervisor ____________

**Unit 3-C, Job Ticket for Job Sheet 1**

DT:B-C-101

## Air Service Circuits
## Unit 3-C

### Job Sheet 2—Inspect and Test Stop Light Circuit Switches, Wiring, and Connectors; Repair or Replace as Needed

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

| Evaluation Criteria | Rating |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Specifications are checked | ______ |
| Adjustments/repairs/replacements are made correctly | ______ |
| Job ticket is filled out properly | ______ |
| Cleanup is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Soap solution
6. Circuit tester
7. Air brake system to be worked on
8. Others—as recommended by instructor and equipment service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Move vehicle into the shop, apply the parking brakes, and block the vehicle wheels.

☐ 4. Start the vehicle and build up air pressure and release parking brakes.

☐ 5. Locate the stop light switch.

☐ 6. Test the switch for air leaks, as follows.

  ☐ a. Coat the switch with a soap solution, and apply the brakes with the foot valve and hold (You may need a helper).

- ☐ b. Check the stop light switch for leaks.
- ☐ c. Check for continuity in both positions at the brake light switch. The switch should be open when at rest and closed when the brake pedal is depressed.

  Note: You must have air pressure in system.

☐ 7. If you have any leaks or continuity test fails, replace stop light switch. Check with instructor.

**Caution: Drain the air brake system before removing the stop light switch. Open the reservoir drain cocks.**

☐ 8. Disconnect electrical wires from switch and remove switch from fitting.

☐ 9. Install new switch of the same type and reconnect wiring.

☐ 10. Check switch operation as in previous steps.

☐ 11. Set parking brakes and remove wheel blocks.

☐ 12. Record findings on job ticket.

☐ 13. Turn in job ticket when finished.

☐ 14. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ____________________________________________

______________________________________________________________

______________________________________________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| TOTAL PARTS/MATERIALS | | | |

## SPECIFICATIONS CHECKED

| | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |

School/Work Name ______________________

Address ______________________

Phone # ______________________

Date In ____________

Date Out ____________

## JOB TICKET

Customer Name ______________________

Customer Address ______________________

Customer Phone # ______________________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ______________________

Services/repairs made: ______________________

| LABOR | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

______________________ Date ____________

Technician ____________

Supervisor ____________

**Unit 3-C, Job Ticket for Job Sheet 2**

DT:B-C-105

# Air Service Circuits
# Unit 3-C

## Job Sheet 3—Inspect and Test Relay Valve; Replace as Needed

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

| **Evaluation Criteria** | **Rating** |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Specifications are checked | ______ |
| Adjustments/repairs/replacements are made correctly | ______ |
| Job ticket is filled out properly | ______ |
| Cleanup is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Soap-water solution
6. Air brake system to be worked on
7. Others—as recommended by instructor and equipment service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Move vehicle into shop, apply the parking brakes, and block the vehicle wheels.

☐ 4. Start the vehicle and build the brake system to cut-out pressure (120psi) and release parking brakes.

☐ 5. Make several service brake applications and check for prompt application and release of the brakes, inspecting the operation of the relay valve. Check service manual for specifications.

☐ 6. With the service brakes released, apply a soap-water solution to the exhaust port of the relay valve and check for excessive leakage.

## Job Sheet 3

☐ 7. While holding a full service brake application, apply a soap-water solution to the exhaust port and check for air leaks.

☐ 8. Check with instructor and record findings on work order. If valve did not pass tests, continue.

**Caution: Open the air reservoir drain cocks to bleed air from the system before removing any lines or plugs.**

☐ 9. Remove all air hoses from the relay valve, cap the hoses, and mark them for reassembly.

☐ 10. Remove the valve mounting bolts and remove the valve.

☐ 11. Replace old valve with a new valve of the same type.

☐ 12. Attach the new relay valve to the vehicle using the bolts, washers, and nuts; torque to specifications.

☐ 13. Connect the air hose fittings to the valve ports; check service manual for tightening.

☐ 14. Check with your instructor and continue.

☐ 15. Close the air reservoir drain cocks and start the vehicle engine to pressurize the air system.

☐ 16. Test relay valve operation using previous steps.

☐ 17. Set parking brakes and remove wheel blocks.

☐ 18. Record findings on job ticket.

☐ 19. Turn in job ticket when finished.

☐ 20. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

______________________________

______________________________

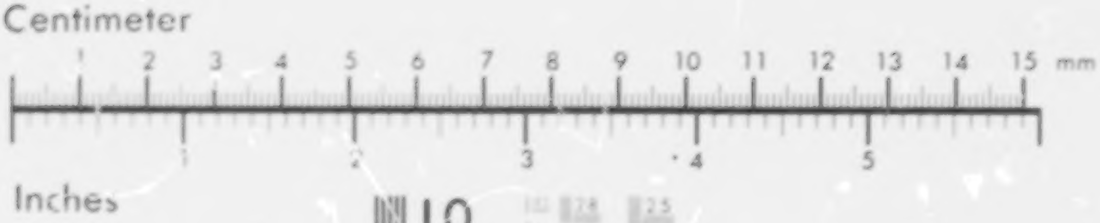
1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5

**AIIM**

**Association for Information and Image Management**

1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910
301/587-8202

1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5


Centimeter
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
mm
1
2
3
4
5
Inches

1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5

1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5

1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5

MANUFACTURED TO AIIM STANDARDS
BY APPLIED IMAGE, INC.

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| TOTAL PARTS/MATERIALS | | | |

## SPECIFICATIONS CHECKED

| | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |

School/Work Name ____________________

Address ____________________

Phone # ____________________

Date In ____________

Date Out ____________

## JOB TICKET

Customer Name ____________________

Customer Address ____________________

Customer Phone # ____________________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ____________________

Services/repairs made: ____________________

| LABOR | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

____________________ Date ____________

Technician ____________

Supervisor ____________

Unit 3-C, Job Ticket for Job Sheet 3

DT:B-C-109

# Air Service Circuits
## Unit 3-C

### Job Sheet 4—Inspect and Test Quick Release Valve; Replace as Needed

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

| Evaluation Criteria | Rating |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Specifications are checked | ______ |
| Adjustments/repairs/replacements are made correctly | ______ |
| Job ticket is filled out properly | ______ |
| Cleanup is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Soap solution
6. Air brake system to be worked on
7. Others—as recommended by instructor and equipment service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Move vehicle into shop, apply the parking brakes, and block the vehicle wheels.

☐ 4. Start the vehicle and build up air pressure and release parking brakes.

☐ 5. Locate the quick release valve in the brake system.

☐ 6. Test valve for operation and air leaks.

☐ 7. Coat the exhaust port with a soap solution and check for leaks. Leakage of a one-inch bubble in three seconds is allowable.

## Job Sheet 4

☐ 8. Coat the valve body and cover with a soap solution. No leakage is permitted between the valve body and cover.

**Caution: Drain the air brake system by opening the reservoir drain cocks before you disconnect any air lines.**

☐ 9. Mark and disconnect the air lines from the quick release valve.

☐ 10. Remove the mounting bolts and the valve.

☐ 11. Replace with new valve of the same type.

☐ 12. Install the quick release valve with the exhaust port facing down. Securely tighten the mounting bolts.

☐ 13. Connect the air lines to the quick release valve in the locations previously marked.

☐ 14. Perform the operating and leakage tests using previous steps.

☐ 15. Set parking brakes and remove wheel blocks.

☐ 16. Record findings on job ticket.

☐ 17. Turn in job ticket when finished.

☐ 18. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

______________________________

______________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| TOTAL PARTS/MATERIALS | | | |

### SPECIFICATIONS CHECKED

| | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |

School/Work Name ______________________
Address ______________________
Phone # ______________________

Date In ______________
Date Out ______________

## JOB TICKET

Customer Name ______________________
Customer Address ______________________
Customer Phone # ______________________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ______________________

______________________

Services/repairs made: ______________________

| LABOR | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

______________________ Date ______________

Technician ______________
Supervisor ______________

Unit 3-C, Job Ticket for Job Sheet 4

# Special Circuits
# Unit 4-C

## Objective Sheet

### Unit Objective

After completing this unit, the student should be able to service special circuits and their components. The student should demonstrate these competencies by completing the assignment sheets and job sheets and by scoring a minimum of 85 percent on the written test.

### Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to the special circuits with their definitions.
2. Distinguish among the purposes of the special circuits for a truck brake system.
3. Identify the components of the parking circuit.
4. Identify the component that is unique to the emergency circuit.
5. Identify the components of the anti-compounding circuit.
6. Describe the two conditions in which compounding can occur.
7. Match special circuit components of the truck brake system with their functions.
8. Identify special circuit components of the truck brake system.
9. Identify the parts and ports of a system park control valve.
10. Complete statements concerning the characteristics of the system park control valve.
11. Identify the ports of an inversion valve.
12. Identify the parts and port of a spring brake.
13. Complete statements concerning the operation of spring brakes.
14. Select true statements concerning regulatory requirements of parking and emergency circuits.
15. Identify components of the tractor brake system.
16. Match truck/tractor circuit components with their functions.
17. Identify the parts of a hand control valve.
18. Identify ports of a tractor protection valve.
19. Identify the parts and ports of a trailer air supply valve.
20. Identify and connect components in a truck brake system. (Assignment Sheet 1)

## Objective Sheet

21. Identify and connect components in a tractor brake system. (Assignment Sheet 2)

22. Inspect and test parking brake hand (control) valve; replace as needed. (Job Sheet 1)

23. Inspect and test inversion valve; replace as needed. (Job Sheet 2)

24. Inspect and test anti-compounding circuit equipped with Quick Release (QR) 1-C; replace as needed. (Job Sheet 3)

25. Inspect and test trailer air supply valves; replace as needed. (Job Sheet 4)

26. Inspect and test trailer brake control valve (hand valve); replace as needed. (Job Sheet 5)

27. Inspect and test tractor protection valve; replace as needed. (Job Sheet 6)

28. Check operation of parking brake; remove, inspect, and replace parking brake (spring brake) chamber as needed. (Job Sheet 7)

# Special Circuits
# Unit 4-C

## Information Sheet

1. **Terms and definitions**

   a. **Cage**—To confine, as if in a cage

   Example: Confining a power spring inside a spring brake

   b. **Compounding**—Combining forces; may cause damage if maximum force allowed is exceeded

   Example: Combining parking brake and service brake forces

   c. **Control pressure**—Pressure within a circuit used to regulate the functioning of the system

   Example: Air pressure used to hold the compressed power spring in a spring brake

   d. **Hand control valve**—Applies trailer brakes only; cannot be used for parking

   e. **Inversion**—Condition of being reversed from the normal position, order, or relationship

   f. **Inversion valve**—Special valve that is normally open instead of normally closed; operates by releasing pressure rather than by applying pressure

   g. **Spring brake**—Tandem-chamber brake actuator that incorporates an air-applied service brake chamber and an air-releasing/spring-applied parking or emergency brake chamber

   h. **Tractor protection valve**—Protects the tractor brake system pressure if the air supply system is shut off or if the pressure drops below the minimum 45 psi

   i. **Trailer air supply valve**—Provides driver control over the flow of air to the trailer

2. **Purposes of special circuits for a truck brake system**

   a. **Parking circuit**—To control the application and release of the spring brake in order to hold the vehicle stationary when stopped

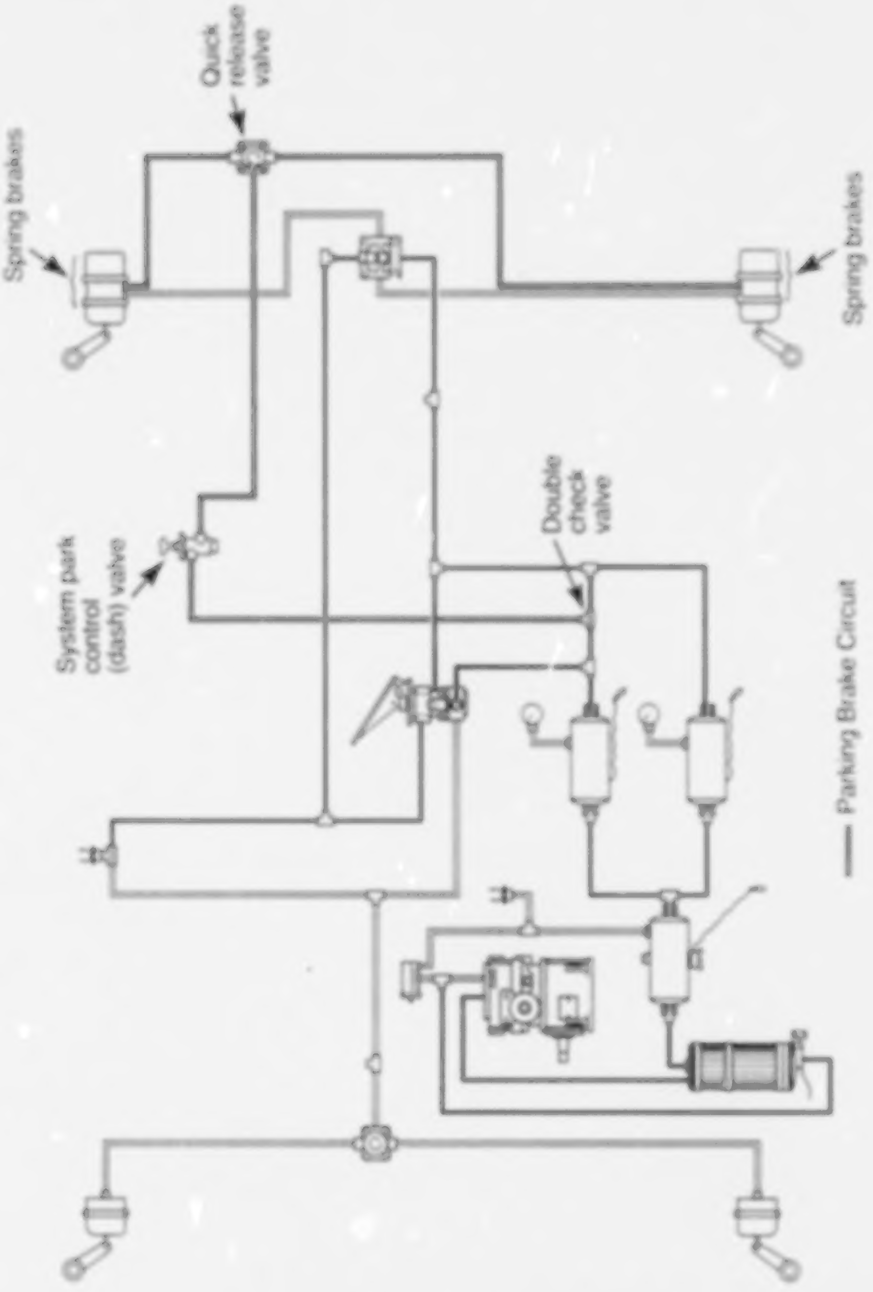
   b. **Emergency circuit**—To apply the brakes in the event of a loss of air pressure in both service brake circuits and/or emergency circuit

   c. **Anti-compounding circuit**—To prevent the application of the spring brake while the service brake is being applied, thereby preventing damage to the foundation brake components

## Information Sheet

### 3. Components of the parking circuit

Figure 1

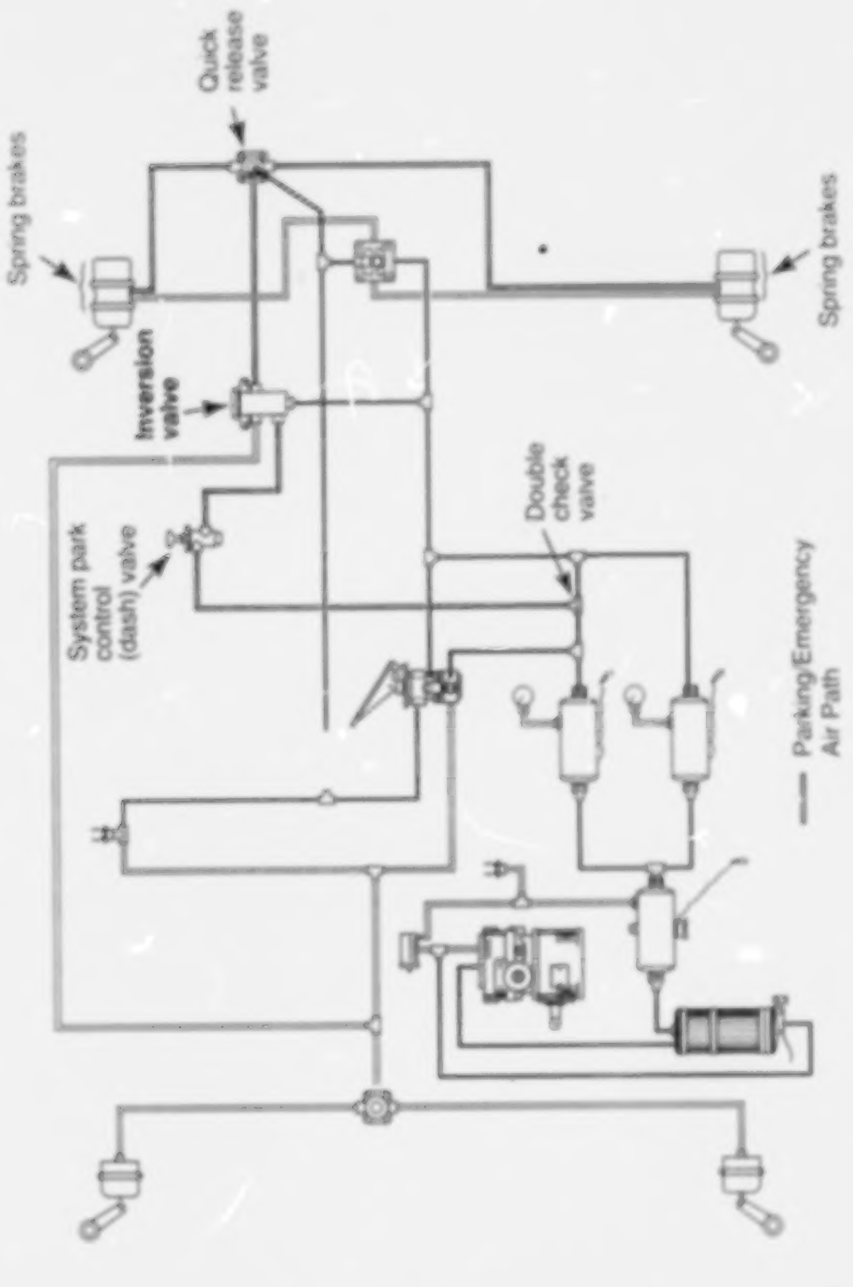

Quick release valve
Spring brakes
Spring brakes
System park control (dash) valve
Double check valve
— Parking Brake Circuit

Courtesy of Haldex Midland Services

## Information Sheet

### 4. Components of the emergency circuit

Figure 2

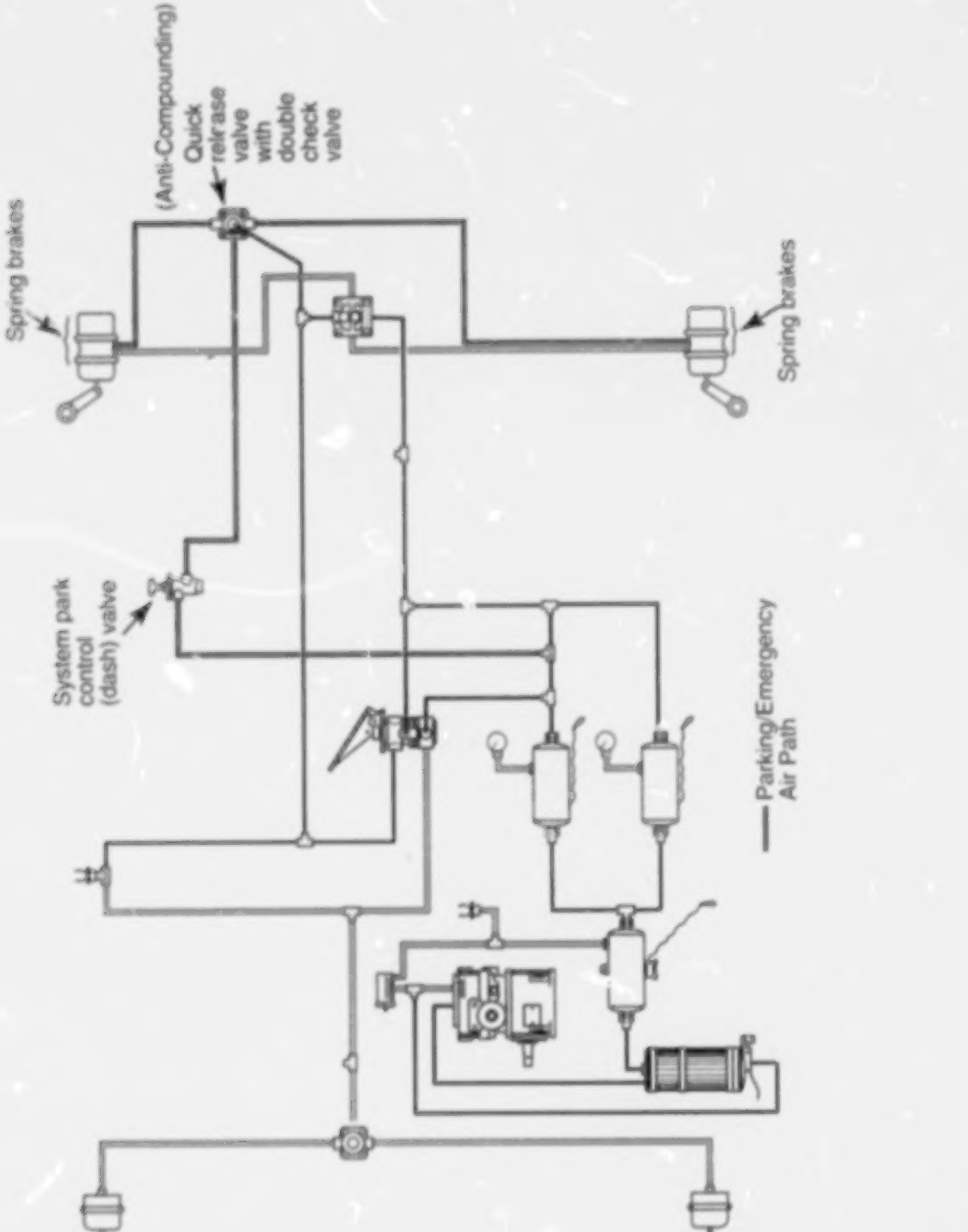

Spring brakes
Quick release valve
Spring brakes
Inversion valve
Double check valve
System park control (dash) valve
— Parking/Emergency Air Path

Courtesy of Haldex Midland Services

## Information Sheet

### 5. Components of the anti-compounding circuit

Figure 3


(Anti-Compounding)
Quick relrase valve with double check valve
Spring brakes
Spring brakes
System park control (dash) valve
— Parking/Emergency Air Path

Courtesy of Haldex Midland Services

## Information Sheet

6. **Conditions in which compounding can occur**

   a. Parking brake is applied while driver has service brakes applied

   b. Service brake application during a low pressure situation

7. **Functions of special circuit components of the truck brake system**

   a. **Double (two-way) check valve**—Senses available air pressure from the primary and secondary service circuits and allows air to be delivered to the parking circuit from the circuit with the higher pressure

   Note: The double check valve is commonly integrated into the quick-release or relay valve for anti-compounding.

   b. **System park control (yellow dash) valve**—Allows driver to apply and release the spring parking and/or emergency) brakes

   c. **Quick release valve**—Releases air from the spring brake chambers to allow application of the spring brakes

   d. **Quick release valve with double check valve**—Dual functions:

      1) Controlled by system park control valve to speed up spring brake application in an emergency situation

      2) Acts as anti-compounding device to balance service brake line pressure with spring brake line pressure

   e. **Spring brakes**—Have two chambers that perform different functions:

      1) Service brake chamber is used for standard service braking.

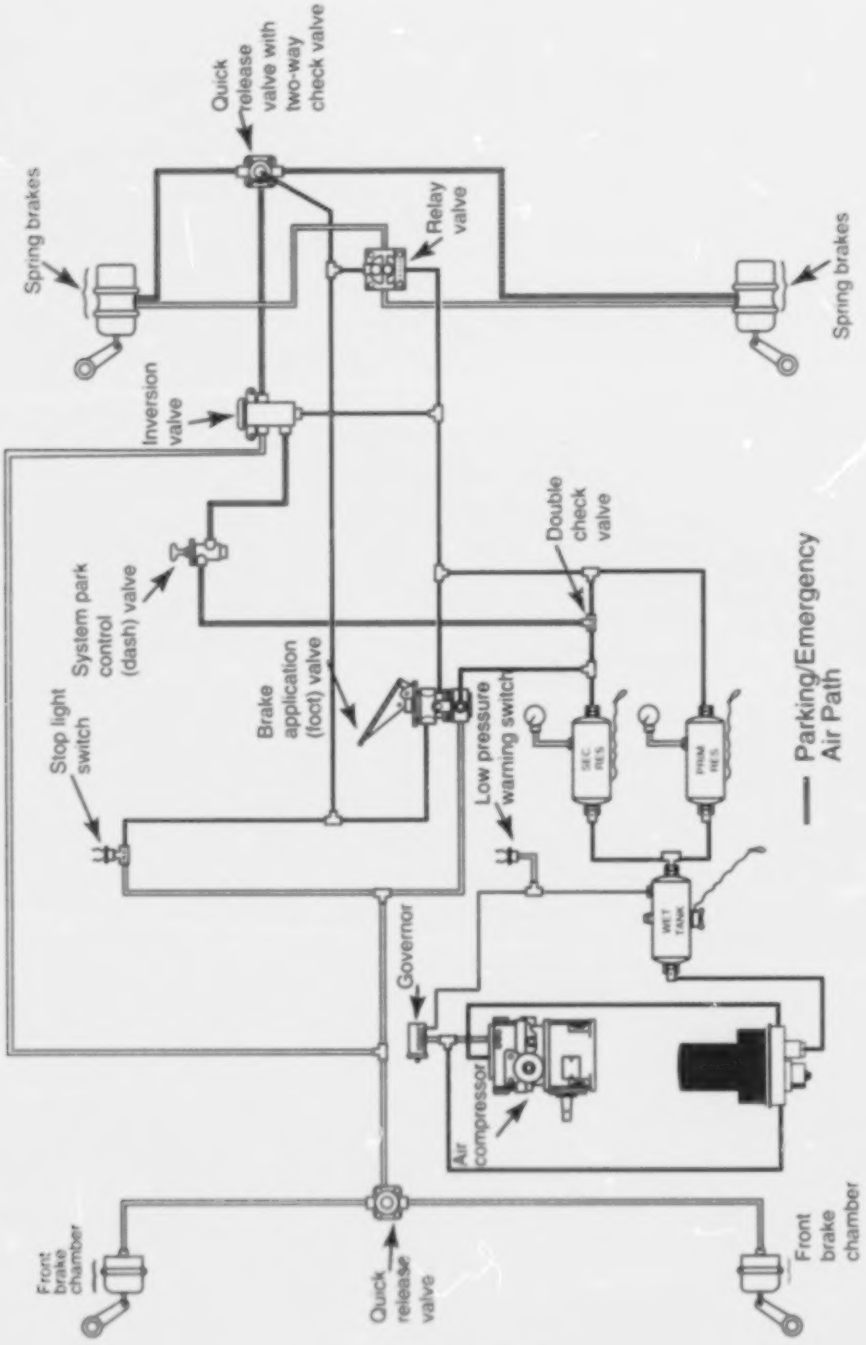
      2) Spring brake chamber is used to apply the service brakes with aid of a power spring in case of air loss that can happen in parking or emergency situations.

   f. **Inversion valve**—Special valve that only operates in the event of a primary service reservoir failure (rear service brakes); senses front brake application pressure and causes the release of air from the spring brakes so mechanical spring brake can assist the front brakes in stopping the vehicle; not used on all systems

## Information Sheet

### 8. Special circuit components of the truck brake system

Figure 4

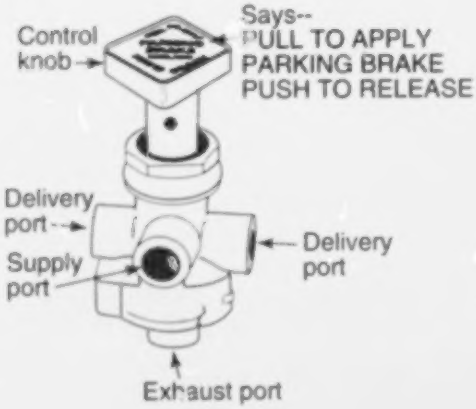

Quick release valve with two-way check valve
Spring brakes
Relay valve
Spring brakes
Inversion valve
Double check valve
System park control (dash) valve
Brake application (foot) valve
Stop light switch
Low pressure warning switch
SEC RES
PRIM RES
— Parking/Emergency Air Path
WET TANK
Governor
Air compressor
Front brake chamber
Quick release valve
Front brake chamber

Courtesy of Haldex Midland Services

**Information Sheet**

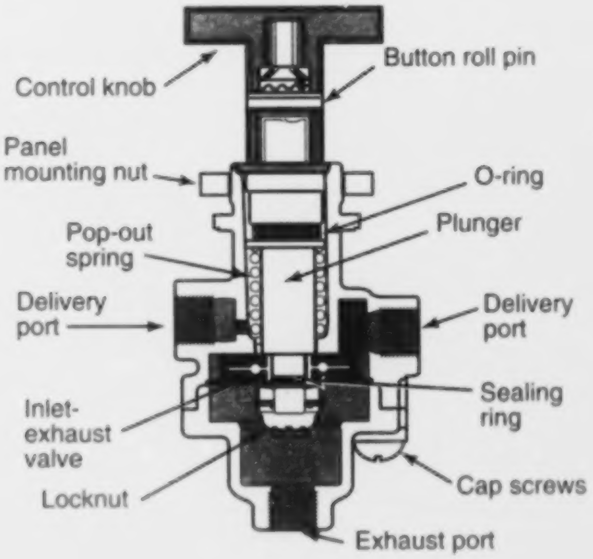
### 9. Parts and ports of a system park control valve

Figure 5—Exterior view


Control knob
Says--
PULL TO APPLY
PARKING BRAKE
PUSH TO RELEASE
Delivery port
Supply port
Delivery port
Exhaust port

Courtesy of Haldex Midland Services

Figure 6—Cross section view


Control knob
Button roll pin
Panel mounting nut
O-ring
Pop-out spring
Plunger
Delivery port
Delivery port
Inlet-exhaust valve
Sealing ring
Cap screws
Locknut
Exhaust port

Courtesy of AlliedSignal Bendix

**10. Characteristics of the system park control valve**

a. Is used on all models with air brakes

b. Has a yellow diamond-shaped control knob

c. Is mounted on the cab's instrument panel (dash)

Note: This valve may be combined with the trailer supply valve as one unit. Refer to Student Supplement 1.

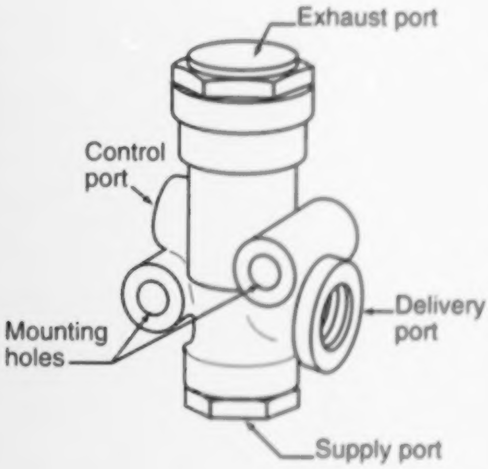
d. Applies vehicle spring brakes when knob is pulled out

e. Will automatically pop out when the system air pressure drops below a pre-determined level (usually 20–40 psi).

f. Can serve as an emergency brake control

**11. Ports of an inversion valve**

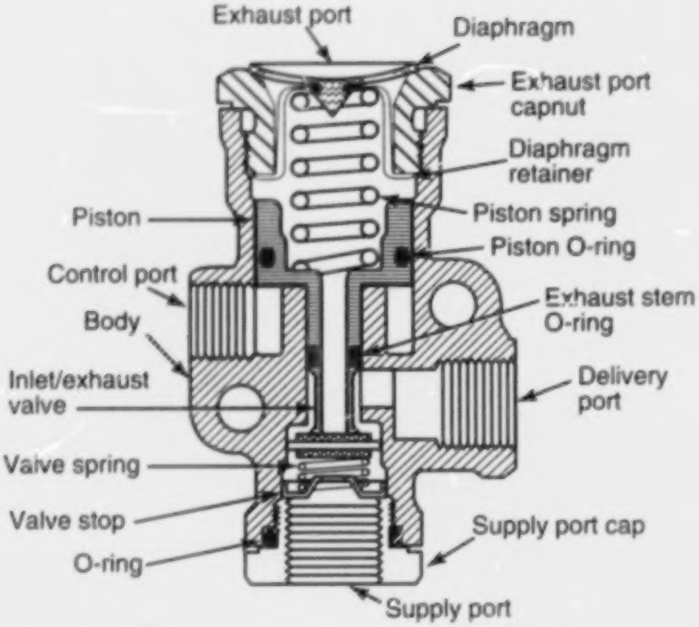
Figure 7—Exterior view


Exhaust port
Control port
Delivery port
Mounting holes
Supply port

Courtesy of AlliedSignal Bendix

**Information Sheet**

Figure 8—Cross section view

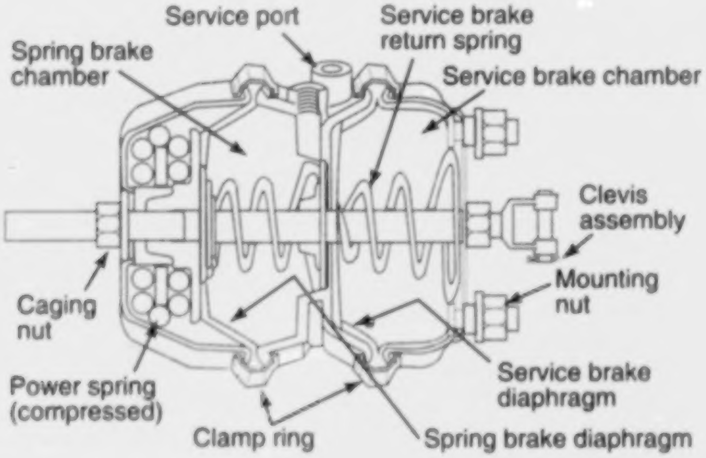

Exhaust port
Diaphragm
Exhaust port capnut
Diaphragm retainer
Piston
Piston spring
Piston O-ring
Control port
Body
Exhaust stem O-ring
Delivery port
Inlet/exhaust valve
Valve spring
Valve stop
Supply port cap
O-ring
Supply port

Courtesy of Freightliner Corporation

12. **Parts and ports of a spring brake (rear axles)**

   a. Spring brake for s-cam type and disc type brakes

   Figure 9

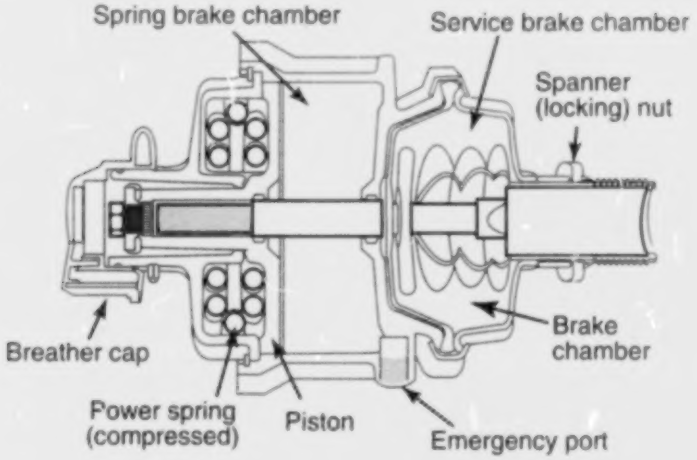

Service port
Service brake return spring
Spring brake chamber
Service brake chamber
Clevis assembly
Mounting nut
Caging nut
Power spring (compressed)
Service brake diaphragm
Clamp ring
Spring brake diaphragm

Courtesy of Haldex Midland Services

## Information Sheet

b. Spring brake for wedge-type brakes

Figure 10


Spring brake chamber
Service brake chamber
Spanner (locking) nut
Brake chamber
Breather cap
Power spring (compressed)
Piston
Emergency port

Courtesy of Haldex Midland Services

### 13. Operation of spring brakes

a. Spring brakes are designed to automatically apply the vehicle's service brakes in case of air loss. This may occur in an emergency situation when air is suddenly lost, or by the operator's activation of a dash-mounted parking brake control valve.

b. Spring brakes remain applied until that chamber is recharged with air or the spring is manually compressed or caged.

c. Spring brakes may be either diaphragm type or piston type, but both rely on air pressure to keep the brake in the compressed position until they are applied manually or automatically.

d. The spring portion often is referred to as the piggy back.

e. Some spring brake actuators do not incorporate a service air chamber and are solely used as parking and emergency brakes.

f. Spring brakes are not needed for normal driving or normal braking, only for emergency or parking situations.

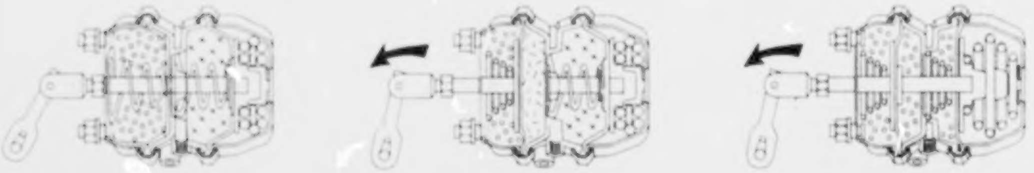
   1) Normal driving—Air pressure within the system holds the spring brakes released by keeping the heavy duty spring compressed.

   2) Normal service brake—Spring brake does not interfere with normal service brake operation.

## Information Sheet

3) Parking or emergency situations—When air pressure drops below a predetermined level, the spring brake mechanically forces the service brake to apply. The brakes will remain applied until sufficient air pressure is restored to the chamber to recompress the spring or the brakes are manually released.

Figure 11—Spring brake stages of operation



**Normal Driving**
Air pressure within the system holds spring brakes released, but always ready for parking or emergency application.

**Normal Service Brake**
Spring brake does not apply with normal service brake application as air pressure keeps the spring caged.

**Emergency Brakes**
The spring brake is installed to operate either automatically upon total loss of air pressure or by foot valve modulated application when there is a loss of pressure in the primary air system.

+ Spring brake hold off pressure

- Service air pressure

○ Atmosphere pressure

**Parking Brakes**
Application of the dash control valve exhausts air from the spring brake chamber, permitting the spring force to apply the service brake for positive parking.

Courtesy of Meritor Automotive, Inc.

g. The compressed power spring in a spring brake is very powerful and very dangerous. It is important that you follow all safety precautions when servicing spring brakes.

h. Always use the manual release to cage the spring brake prior to service to prevent unwanted application.

i. When spring brakes are caged, they are released. Make sure wheels are blocked.

j. When spring brake diaphragm problems occur, replace the old unit with the new sealed spring brake units. These new designs are much safer.

### 14. Regulatory requirements of parking and emergency circuits (FMVSS121)

a. Must be capable of holding the fully loaded vehicle stationary while it is parked on a 20% grade

b. Must apply automatically if reservoir pressure drops below a specific level

c. Must be effective despite a failure in other brake circuits, including service brakes

d. Must have a separate control

e. For emergency brakes, must be capable of stopping the vehicle within specified stopping distances

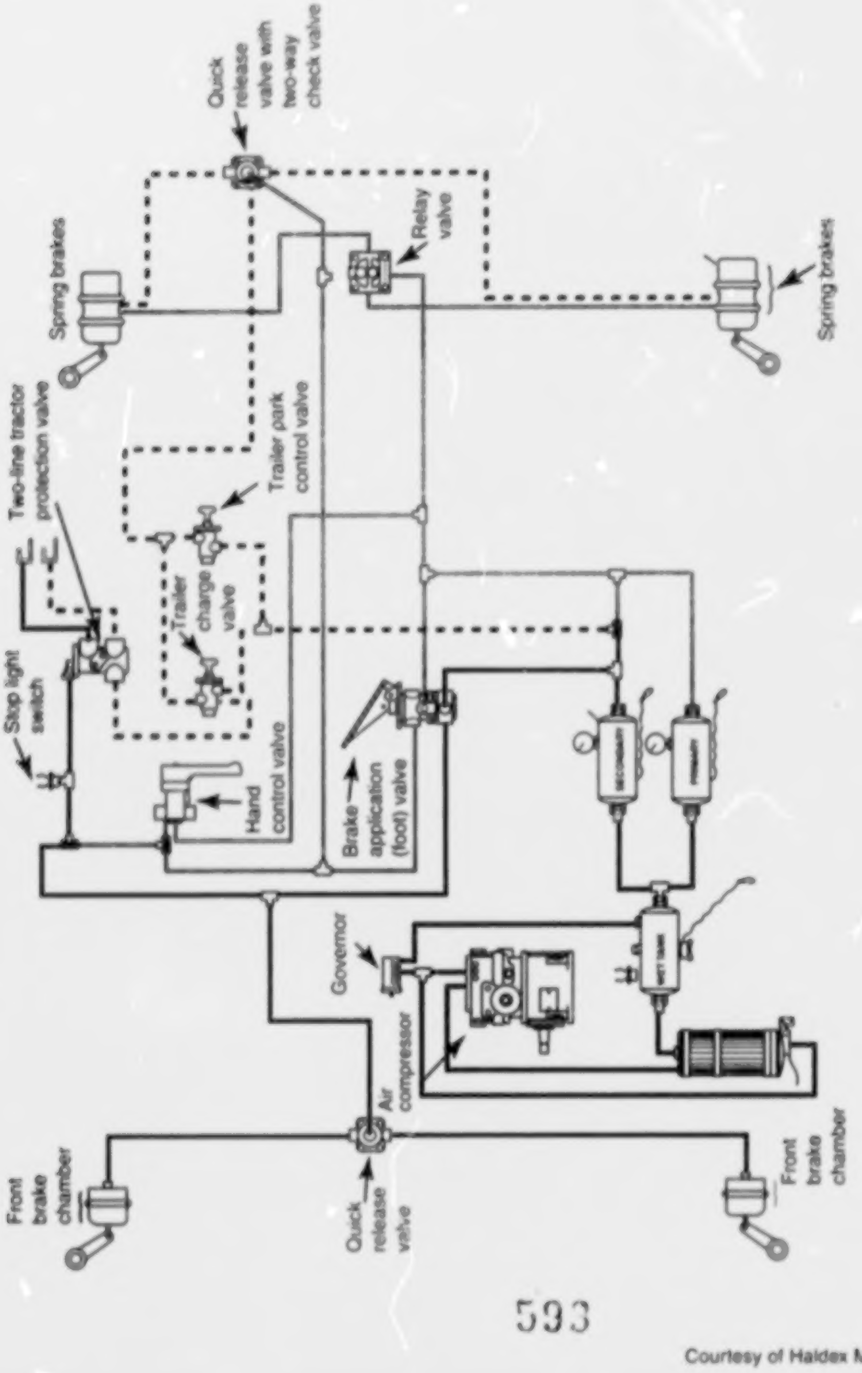
f. Must be able to release at least once after automatic application

g. Must achieve required park within 3 seconds

## Information Sheet

### 15. Components of the tractor brake system

Figure 12


Quick release valve with two-way check valve
Relay valve
Spring brakes
Spring brakes
Two-line tractor protection valve
Trailer park control valve
Trailer charge valve
Stop light switch
Hand control valve
Brake application (foot) valve
Governor
Air compressor
Front brake chamber
Quick release valve
Front brake chamber

Courtesy of Haldex Midland Services

## Information Sheet

16. **Functions of truck/tractor circuit components**

    a. **Hand control valve**—Controls the trailer brakes only

    1) Used by some drivers to assist their braking effort

    2) Requires a two-way check valve to allow control pressure from either the hand control vavle or hte foot control vavle

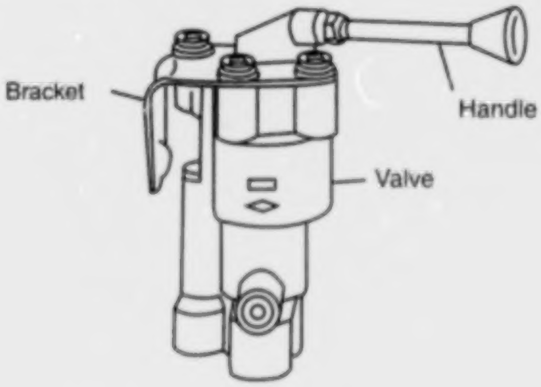
    b. **Tractor protection valve**—Protects the tractor's air system in the event of a failure in the trailer or a trailer break-away

    c. **Trailer air supply valve**—Supplies pressurized air to the trailer brake system; works in conjunction with the tractor protection valve

    Note: A double valve with two-way check valve is optional on some tractor brake systems. This valve is shown as an option on the truck/tractor brake circuit in Student Supplement 1.

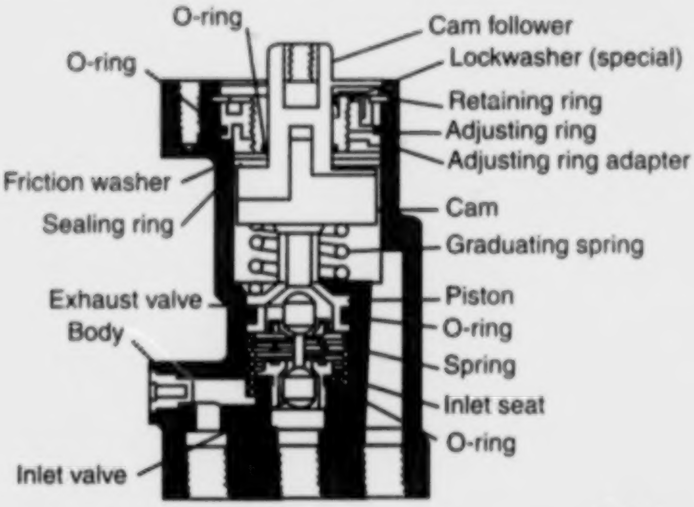
17. **Parts of a hand control valve**

Figure 13—Exterior view


Bracket
Handle
Valve

Courtesy of AlliedSignal Bendix

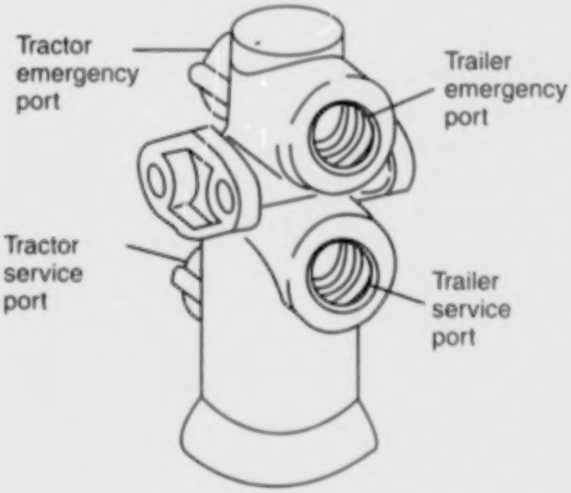
Figure 14—Cross section view


O-ring
Cam follower
O-ring
Lockwasher (special)
Retaining ring
Adjusting ring
Adjusting ring adapter
Friction washer
Cam
Sealing ring
Graduating spring
Exhaust valve
Piston
Body
O-ring
Spring
Inlet seat
O-ring
Inlet valve

Courtesy of AlliedSignal Bendix

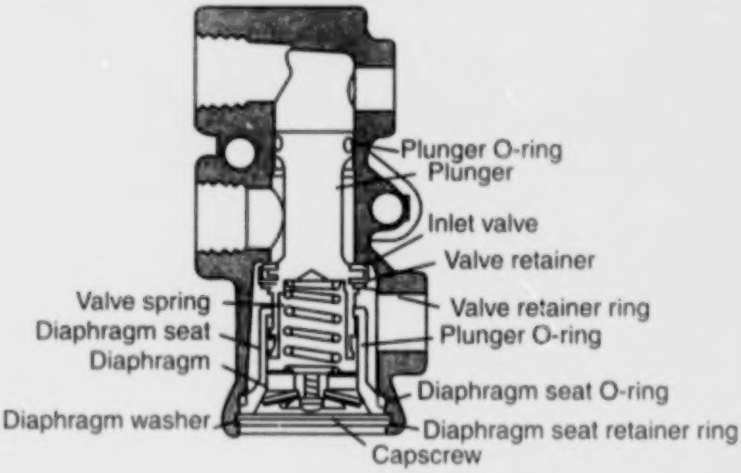
## 18. Ports of a tractor protection valve

Figure 15—Exterior view


Tractor emergency port
Trailer emergency port
Tractor service port
Trailer service port

Courtesy of AlliedSignal Bendix

Figure 16—Cross section view

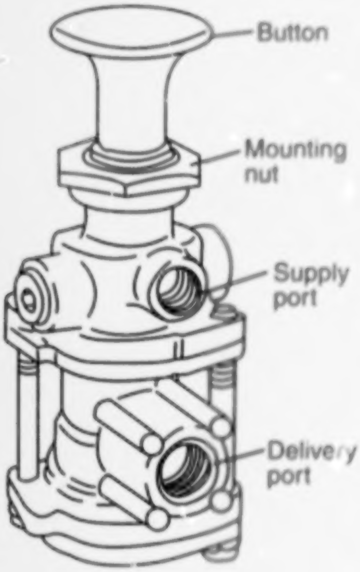

Plunger O-ring
Plunger
Inlet valve
Valve retainer
Valve spring
Valve retainer ring
Diaphragm seat
Plunger O-ring
Diaphragm
Diaphragm seat O-ring
Diaphragm washer
Diaphragm seat retainer ring
Capscrew

Courtesy of AlliedSignal Bendix

## Information Sheet

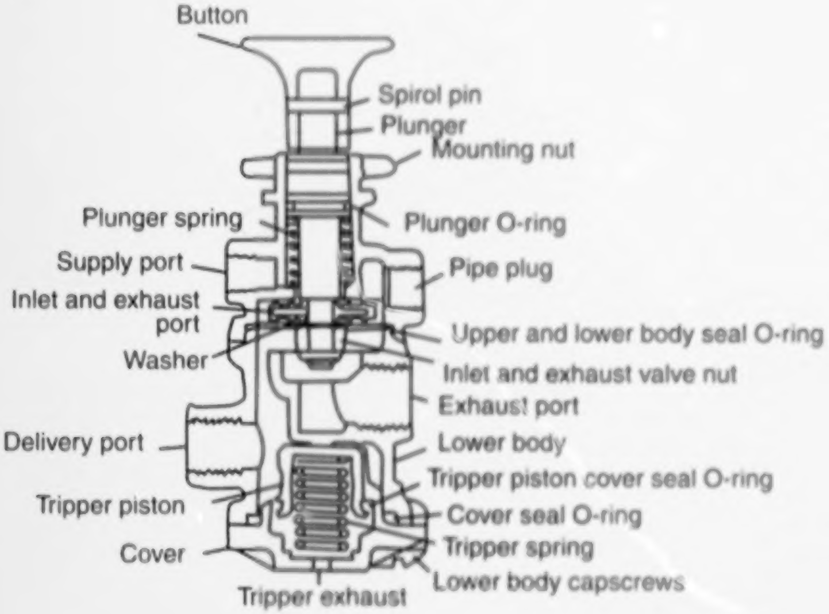
### 19. Parts and ports of a trailer air supply valve

Figure 17—Exterior view


Button
Mounting nut
Supply port
Delivery port

Courtesy of AlliedSignal Bendix

Figure 18—Cross section view

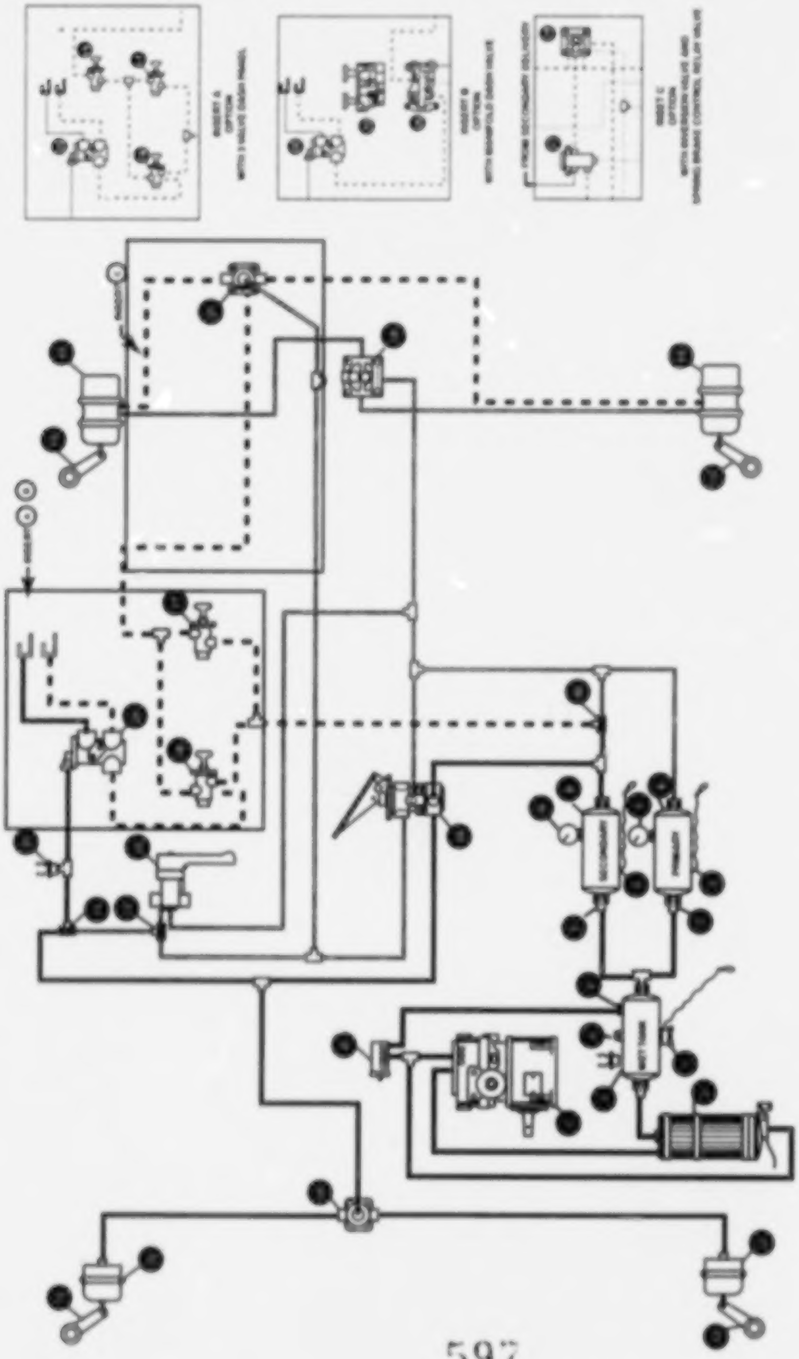

Button
Spirol pin
Plunger
Mounting nut
Plunger spring
Plunger O-ring
Supply port
Pipe plug
Inlet and exhaust port
Upper and lower body seal O-ring
Washer
Inlet and exhaust valve nut
Exhaust port
Delivery port
Lower body
Tripper piston cover seal O-ring
Tripper piston
Cover seal O-ring
Tripper spring
Cover
Lower body capscrews
Tripper exhaust

Courtesy of AlliedSignal Bendix

# Special Circuits
## Unit 4-C

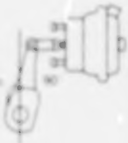
### Student Supplement 1—Truck/Tractor Troubleshooting Guide

Note: This troubleshooting guide is courtesy of Haldex Midland Services.



## Student Supplement 1

| COMPLAINT | REMEDY |
|---|---|
| **1 COMPRESSOR** | |
| PUMPS BEYOND "CUT-OUT" | Check gauge<br>Check governor<br>Be certain it pressurizes unloader port when above "cut-out".<br>Check unloader plungers.<br>Lube, kit or change head |
| WON'T PUMP AIR | Check gauge<br>Check compressor drive<br>Check inlet valves and plungers.<br>If stuck, leak will be evident at intake when unloaded. Install unloader kit head kit or head assy. |
| SLOW PRESSURE BUILD UP | Check gauge<br>Check compressor drive<br>Check intake for restriction.<br>Check discharge line for restriction.<br>Check unloader function.<br>Lube or kit.<br>Check inlet and exhaust valves.<br>Leak will be evident at intake when unloaded, kit or exchange head. |
| PUMPS EXCESSIVE OIL | Check oil return for restriction, kink, or loop.<br>Check for gasket sealant obstructing drain.<br>Check for undersize return line (1/2" min.)<br>Check for fitting restricting drain.<br>Check intake vacuum (20" water maximum).<br>Check for excessive engine crankcase pressure (poor engine ventilation).<br>Check compressor ring wear.<br>Exchange for service unit. |
| **2 WET TANK** | |
| EXCESS OIL ACCUMULATION | See #1 Complaint — Pumps excessive oil |
| EXCESS WATER ACCUMULATION | Drain daily<br>Install automatic drain on wet tank |
| DAMAGED | Replace |
| **3 LOW PRESSURE INDICATOR SWITCH** | |
| BUZZER OR LIGHT INOPERABLE | Check ground and wiring on switch and buzzer/light.<br>Replace switch or buzzer/light. |
| WON'T OPERATE AT PRESSURES BELOW 60 P.S.I. | Check dash gauge for accuracy.<br>Replace switch or buzzer/light. |
| **4 SAFETY VALVE** | |
| "POPS" OFF EXCESSIVELY | Check system pressure.<br>Valve operating properly if venting at 140/150 p.s.i.<br>Check governor/unloader. |
| "POPS" OFF AT LESS THAN 140 P.S.I. | Replace |
| LEAKS | Replace |
| WON'T FUNCTION | Periodic Test<br>Remove and test above 150 p.s.i. with shop air.<br>Replace if non-functional. |
| **5 DRAIN VALVES — MANUAL** | |
| LEAKS | Replace |
| **DRAIN VALVES — AUTOMATIC** | |
| WON'T DRAIN | Repair or replace |
| WON'T DRAIN IN COLD WEATHER | Replace with heated unit |
| LEAKS — MALFUNCTIONS | Repair or replace<br>Periodic Test<br>With system pressure stabilized (compressor unloaded) no leak evident at discharge port, make several foot brake applications to reduce wet tank pressure. Moisture should drain from discharge port. |
| **6 GOVERNOR** | |
| FLUTTERS | Check gauge<br>Check unloader line size (5/16" x 5' maximum).<br>Check air activated accessory.<br>Is the air volume requirement greater than governor capacity?<br>Check for plugged governor reservoir line.<br>Repair, adjust, or replace governor. |
| WON'T PASS AIR TO UNLOADER TO "CUT-OFF" COMPRESSOR | Check governor reservoir line.<br>Repair or replace. |
| **7 SINGLE CHECK VALVE** | |
| ALLOW BLEED BACK TO SUPPLY RESERVOIR | Periodic Test<br>Bleed supply reservoir and observe gauges.<br>Check valve should maintain rear and front reservoir pressure.<br>Replace if test results are negative. |
| **8 PRIMARY AND SECONDARY RESERVOIR** | |
| EXCESS OIL/WATER | Drain as required.<br>Check automatic drain valve on wet tank for proper operation. See #5. |
| **9 AIR GAUGE** | |
| INCORRECT READING | Calibrate, replace, or see your dealer. |
| **10 DUAL SYSTEM FOOT BRAKE VALVE** | |
| LEAKS AT EXHAUST WITH HAND VALVE APPLIED | Check<br>Double check valve #23 or #24<br>repair or replace. |
| LEAKS AT EXHAUST WITH ALL BRAKES RELEASED | Check anti-compound double check valve #20 or #27 for back flow.<br>CAUTION: BLOCK WHEELS.<br>Repair or replace #20 or #27.<br>Check foot valve for inlet valve leak.<br>Repair or replace. |
| LEAKS AT EXHAUST WITH FOOT BRAKE APPLIED | Foot valve defective.<br>Repair or replace. |
| **11 QUICK RELEASE VALVE** | |
| LEAKS (WHEN USED IN SERVICE BRAKE SYSTEM) | Replace |
| LEAKS (WHEN USED IN SPRING BRAKE SYSTEM) | Replace |
| **12 SERVICE BRAKE CHAMBER** | |
| LEAKS | Replace diaphragm.<br>(Set park brake).<br>Reset clamps.<br>Adjust brakes. |
| WITH SERVICE BRAKES APPLIED STROKE IS AT OR BEYOND MAXIMUM LIMIT OF:<br>Type 9 1-3/8" Type 20 1-3/4"<br>Type 12 1-3/8" Type 24 1-3/4"<br>Type 16 1-3/4" Type 30 2" | |
| SLUGGISH APPLICATION OR RELEASE | Check basic brake.<br>Check for air line restriction/leak.<br>Align linkage.<br>Check chamber return spring.<br>Adjust brakes.<br>Angle should approach 90° on application.<br>Check for improper chamber or obstruction. |
| **13 SLACK ADJUSTER** | |
| SLEEVE WILL NOT DEPRESS | Clean and lubricate or replace with unit dimensionally same. |
| ADJUSTING SHAFT WILL NOT TURN | Replace with unit dimensionally same. |
| CRACKED HOUSING | Check springbrake anti-compound system.<br>Check air chamber size.<br>Replace if larger than original size.<br>Check direction of travel for proper position of hex nut (shown under #12).<br>Hex nut must face away from chamber for unidirectional slack adjuster. |
| WORN CLEVIS PIN BUSHING | Replace bushing |
| **14 RELAY VALVE** | |
| LEAKS AT EXHAUST PORT WITH ALL BRAKES RELEASED | Check seal in springbrake for back flow of spring "hold off" pressure through service port to open exhaust on valve.<br>Replace #11.<br>Check inlet valve in relay valve for leak.<br>If reservoir section of valve shows evidence of contamination, check supply lines for rusty fittings or carbon deposits.<br>Repair or replace. |
| LEAKS AT EXHAUST PORT WITH SERVICE BRAKES APPLIED | Exhaust valve not sealing properly.<br>Repair or replace. |



BRAKE RELEASED

BEST COPY AVAILABLE

## Student Supplement 1

| COMPLAINT | REMEDY |
|---|---|
| **SPRING PARKING BRAKE (SERVICE ONLY SERVICE CHAMBER SIDE OF SPRING BRAKE).** | |
| PARK BRAKE DRAGS OR WON'T RELEASE | Check for<br>Improper adjustment, restriction, or broken line<br>Diaphragm failure<br>System pressure too low<br>Improper manual release<br>Broken return spring (spring side)<br>Quick release of relay malfunction<br>Broken power spring<br>Replace entire unit or piggy back emergency section |
| SLUGGISH PARK APPLICATION | Check for<br>Failed springbrake diaphragm<br>Improper manual release<br>Broken power spring |
| LEAKS WHEN PRESSURIZED FOR PARK AND BRAKE RELEASE | Check for<br>Ruptured spring side diaphragm<br>Push rod seal leakage (may be evident at #14) |
| SERVICE CHAMBER MALFUNCTION | See #12 |
| **DOUBLE CHECK VALVE UNITES FRONT BRAKE AND REAR BRAKE RESERVOIRS TO FEED PARK CONTROL (INSERT & OPTION WITH 2 VALVE DASH PANEL).** | |
| REAR TANK BLEED-DOWN ALSO BLEEDS FRONT TANK OR VICE VERSA | Periodic Test: pressure should remain in one tank after the other is drained. Replace if inoperative. |
| **TRACTOR-TRAILER PARK CONTROL VALVE (YELLOW DIAMOND)** | |
| LEAKS AT EXHAUST PORT | Replace |
| PARK BRAKE WON'T RELEASE | Check for full system pressure delivery thru valve |
| PARK BRAKE WON'T APPLY | Replace if it will not release pressure |
| **TRAILER CHARGE VALVE (RED OCTAGONAL)** | |
| LEAKS AT EXHAUST PORT | Replace |
| DRIVER MAY "OVER-RIDE" AUTOMATIC TRAILER BRAKES WHEN TRACTOR AIR IS BELOW 20 P.S.I. | Replace if T.P. system is automatic and 2-line.<br>Repair or replace #20 if T.P. system is automatic and 3-line. |
| WON'T APPLY TRAILER IMMEDIATELY WHEN "PULLED" | Replace if it won't exhaust.<br>Repair or replace #20 or #19 if #18 is functional. |
| **TRACTOR ONLY PARK VALVE (BLUE ROUND)** | |
| LEAKS AT EXHAUST PORT | Repair or replace |
| **TWO-LINE TRACTOR PROTECTION VALVE (NON-AUTOMATIC TYPE)** | |
| WILL NOT RESPOND TO TRAILER CHARGE VALVE | Repair or replace |
| SUPPLY LINE TO TRAILER WITH SLOW BLEED DOWN DOES NOT SHUT OFF TRACTOR AIR AND VENT BETWEEN 45 AND 20 P.S.I. | Check trailer charge valve #18, as it should "pop" to let T.P. valve vent trailer supply.<br>Repair or replace |
| LEAKS AT EXHAUST PORT OR TRACTOR SERVICE (BACK THRU HAND OR FOOT VALVE) OR TRAILER SUPPLY | Repair or replace |
| **QUICK RELEASE & DOUBLE CHECK VALVE COMBINATION** | |
| FOOT VALVE EXHAUST LEAK | Check double valve portion for feed-back to foot valve.<br>Repair or replace |
| LEAKS WITH ALL BRAKES RELEASED | Repair or replace |
| **HAND CONTROL VALVE-TRAILER SERVICE BRAKES** | |
| LEAKS AT EXHAUST PORT WHEN RELEASED AND FOOT VALVE IS APPLIED | Check #23 or #24 |
| LEAKS AT EXHAUST PORT WHEN IN APPLIED OR RELEASE POSITION | Repair or replace |
| **DOUBLE CHECK VALVE SEPARATES TRAILER HAND VALVE PRESSURE FROM REAR FOOT BRAKE PRESSURE FOR DELIVERY TO TRAILER** | |
| FOOT VALVE EXHAUST PORT LEAKS WHEN HAND VALVE IS APPLIED | Replace |
| HAND VALVE EXHAUST PORT LEAKS WHEN FOOT VALVE IS APPLIED | Replace |
| **DOUBLE CHECK VALVE SEPARATES FRONT AXLE FOOT BRAKE PRESSURE FROM REAR AXLE FOOT BRAKE PRESSURE AND/OR TRAILER HAND VALVE PRESSURE FOR DELIVERY TO TRAILER** | |
| LEAKS THRU FOOT VALVE EXHAUST WITH HAND VALVE APPLIED | Replace #23 or #24 |
| | Periodic Test:<br>Alternately loosen each inlet line and apply pressure to other.<br>If leak is detected — replace |
| **STOP LIGHT SWITCH** | |
| LEAKS | Replace |
| FAILS TO SIGNAL A GOOD BULB THRU SOUND WIRING AT 3-6 P.S.I. | Replace |
| **DOUBLE DASH VALVE WITH BUILT-IN W-WAY CHECK. (RED OCTAGON) TRAILER CHARGE. (YELLOW DIAMOND) TRACTOR PARK.** | |
| PARK BRAKE WON'T RELEASE | Check for full system pressure delivery thru valve. |
| PARK BRAKE WON'T APPLY | Repair or Replace if it will not release pressure. |
| LEAKS AT EXHAUST PORT | Repair or Replace. |
| DRIVER MAY "OVER-RIDE" AUTOMATIC TRAILER BRAKES WHEN TRACTOR AIR IS BELOW 20 P.S.I. | Replace if T.P. System is automatic and 2-line. Repair or Replace if T.P. valve is automatic and 3-line. |
| WON'T APPLY TRAILER IMMEDIATELY WHEN "PULLED" | Replace if it won't exhaust. Repair or Replace #20 if #26 is functional. |
| REAR TANK BLEED-DOWN ALSO BLEEDS FRONT TANK OR VICE VERSA | Periodic Test. Pressure should remain in one tank after the other is drained. Replace if inoperative. |
| **INVERSION RELAY VALVE WITH THE LOSS OF REAR SERVICE SUPPLY, APPLICATION OF SPRING BRAKE BY USING THE EMERGENCY SECTION SHOULD BE AVAILABLE ALONG WITH FRONT SERVICE BRAKE BY APPLYING FOOT VALVE** | Periodically test by bleeding rear service tank and observing front brake and rear spring brake application upon depressing foot pedal.<br>Repair or replace if after checking, piping is non-functional. |
| LEAKS | Repair or replace. |
| **BARRIER WHEEL OIL SEALS*** | |
| **OIL LEAK** | Check for proper glazing of the sealing lip.<br>Check serrations on O.D. and I.D. to see that sealing surfaces are dry. If wet, this could denote the leakage path.<br>Check area between positioning pads. If wet, suspect seal leak.<br>Check seal for damage to seal during installation.<br>Check hub bore and spindle surfaces for imperfections or irregularities.<br>Check to be sure that proper seal has been installed for the particular axle application. |
| **AIR DRYER** | |
| AIR LEAKING CONSTANTLY FROM PURGE VALVE | Purge valve seal damaged. Replace purge valve seal #RN50F<br>Purge valve frozen.<br>Inspect heater (see heater problems). Remove purge tube and push valve shut. |
| HEATER INOPERATIVE | Blown Fuse<br>Check fuse and replace with 8-10 amp fuse<br>Broken wires or poor connections.<br>Repair or replace wiring to heater |
| SLOW WET TANK BUILD-UP | Filter and/or desiccant plugged.<br>Service dryer |

*Barrier Oil Seals not shown in schematic.

BEST COPY AVAILABLE

## Special Circuits
## Unit 4-C

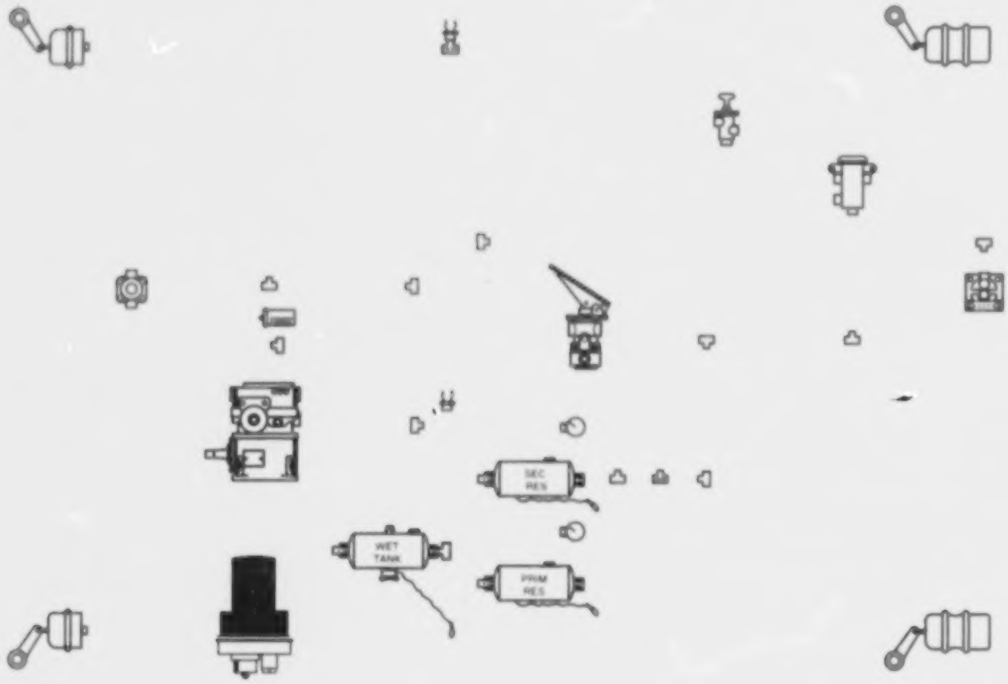
### Assignment Sheet 1—Identify and Connect Components in a Truck Brake System

Name ______________________ Overall Rating ____________

| Evaluation Criteria | Rating |
|---|---|
| Components are correctly identified | ______ |
| Components are correctly connected | ______ |

Directions: Shown below are the components that make up the truck brake system. Identify each component and then draw lines that connect the components for the truck brake system.

Figure 1



Courtesy of Haldex Midland Services

# Special Circuits
## Unit 4-C

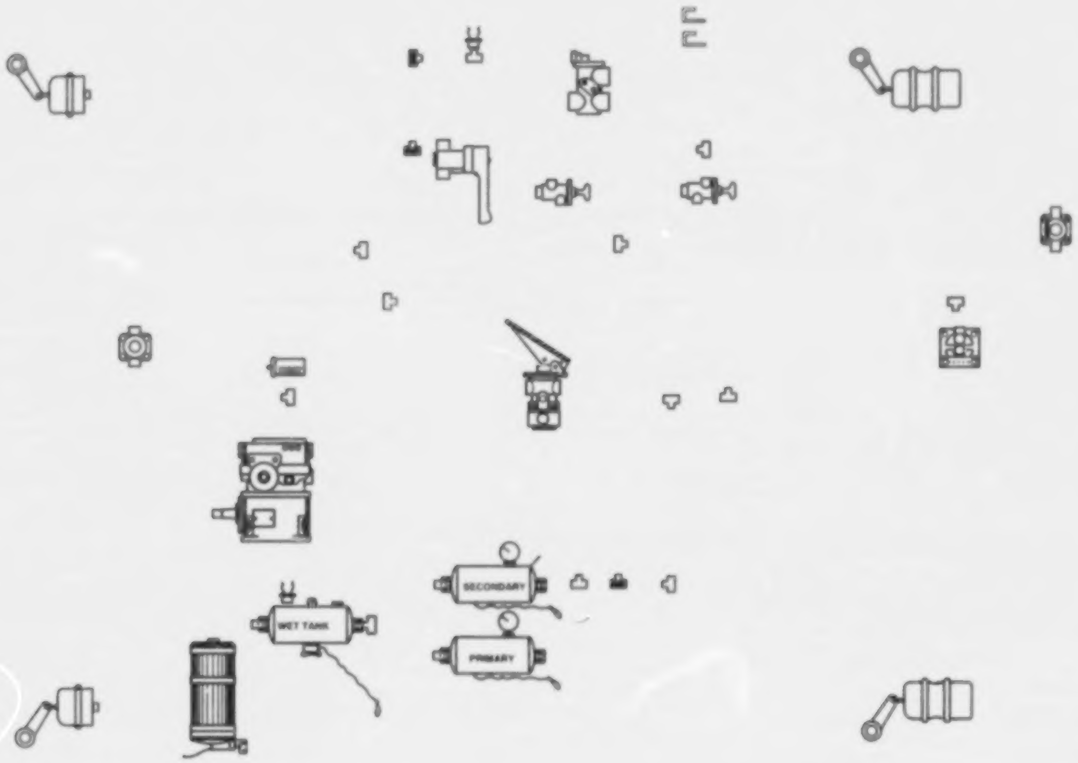
### Assignment Sheet 2—Identify and Connect Components in a Tractor Brake System

Name ______________________________ Overall Rating ______________

| **Evaluation Criteria** | **Rating** |
|---|---|
| Components are correctly identified | ______ |
| Components are correctly connected | ______ |

Directions: Shown below are the components that make up the tractor brake system. Identify each component and then draw lines that connect the components for the tractor brake system.

Figure 1



Courtesy of Haldex Midland Services

# Special Circuits
## Unit 4-C

### Job Sheet 1—Inspect and Test Parking Brake Hand (Control) Valve; Replace as Needed

Name ______________________ Attempt Number ______________

Date ______________________ Overall Rating ______________

| **Evaluation Criteria** | **Rating** |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Specifications are checked | ______ |
| Repair/replacements are made correctly | ______ |
| Job ticket is filled out properly | ______ |
| Cleanup is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Soap solution
6. (3) Test air gauges and fittings
7. Air brake system to be worked on
8. Others—as recommended by instructor and service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Move vehicle into the shop.

☐ 4. Apply the parking brakes.

☐ 5. Block the vehicle wheels.

**Caution: Open the air reservoir drain cocks to bleed air from the system before removing any lines or plugs.**

## Job Sheet 1

☐ 6. To perform an operating test, connect two separate 120 psi air sources to the park valve supply ports and tee an accurate test gauge into the supply lines, and provide for a means to control supply line pressure. Connect a small volume air source with a gauge to the delivery port.

☐ 7. Start the engine and build up the air pressure to the normal operating level.

☐ 8. With the valve knob pulled out, supply either supply port with 120 psi of pressure. Push the valve knob in. Air pressure should rise in the delivery line and equal supply line pressure. Pull the valve knob out. Delivery pressure should exhaust to zero.

☐ 9. Build air pressure to each supply source to 120 psi. Decrease supply pressure at the secondary service reservoir supply port at a rate of 10 psi per second. Primary supply pressure and delivery pressure should not drop below 100 psi. Repeat this step for decreasing primary service reservoir pressure.

☐ 10. Build air pressure to each supply source to 120 psi. Then, decrease both supply pressures to below 20 to 30 psi. The valve knob should automatically pop out when the pressure is within that range.

☐ 11. Test the valve for air leaks. With air pressure at 120 psi and valve knob pulled out, coat the exhaust port and the plunger stem with the soap solution. Leakage should not exceed a 1-inch bubble every five seconds.

☐ 12. Push valve knob in, then coat the exhaust port and plunger stem with the soap solution. Leakage should not exceed a 1-inch bubble in five seconds.

☐ 13. If valve does not work as described or does not pass air leak test replace the valve.

**Caution: Drain air reservoirs before disconnecting air lines.**

☐ 14. To replace the park control valve; remove the top-center dash panel.

☐ 15. Turn the valve knob counterclockwise and remove it from the valve stem.

☐ 16. Mark the air lines and disconnect them from the valve assembly.

☐ 17. Remove the screws that attach the valve to the instrument panel. Remove valve.

☐ 18. Install new valve assembly in the instrument panel and install mounting screws.

☐ 19. Connect the air lines to the applicable fittings and tighten.

☐ 20. Screw the valve knob onto the valve stem.

☐ 21. Retest new valve by using the previous steps.

☐ 22. Set parking brake and remove wheel blocks.

☐ 23. Record work on job ticket.

**Job Sheet 1**

☐ 24. Turn in job ticket when finished.

☐ 25. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| TOTAL PARTS/MATERIALS | | | |

## SPECIFICATIONS CHECKED

| | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |

School/Work Name ______________________

Address ______________________

Phone # ______________________

Date In ______________

Date Out ______________

## JOB TICKET

Customer Name ______________________

Customer Address ______________________

Customer Phone # ______________________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ______________________

Services/repairs made: ______________________

| LABOR | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

______________________ Date ______________

Technician ______________

Supervisor ______________

Unit 4-C, Job Ticket for Job Sheet 1

DT:B-C-145

# Special Circuits
# Unit 4-C

## Job Sheet 2—Inspect and Test Inversion Valve; Replace as Needed

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

| Evaluation Criteria | Rating |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Specifications are checked | ______ |
| Repair/replacements are made correctly | ______ |
| Job ticket is filled out properly | ______ |
| Cleanup is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Soap solution
6. (2) Pressure gauges
7. Air brake system to be worked on
8. Others—as recommended by instructor and service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Move vehicle into the shop.

☐ 4. Apply the parking brakes.

☐ 5. Block the vehicle wheels.

**Caution: Open the air reservoir drain cocks to bleed air from the system before removing any lines or plugs.**

## Job Sheet 2

☐ 6. Tee two pressure gauges in the brake system: one in a common control and supply line and one in the delivery port.

☐ 7. Start the vehicle and build up air pressure and release parking brakes.

☐ 8. With the red dash knob pushed in and pressure coming to the control port from the trailer supply line, the valve should close. There should be 0 psi at the delivery port.

☐ 9. With air pressure in the supply and control ports, apply soap solution around the supply port capnut. If leakage exceeds a 1-inch soap bubble within three seconds, replace the O-ring. If leakage continues, replace the valve.

☐ 10. Exhaust the line coming in to the control port by pulling out the red dash knob in the cab. The pressure gauge at the delivery port should be the same pressure as is being fed the valve at the supply port.

☐ 11. Replace the valve if pressures are not at the rates specified above.

☐ 12. Remove the test gauges from the brake system.

☐ 13. To replace inversion valve, drain air system. See **caution** on previous page.

☐ 14. Identify (mark) and disconnect the three air lines from the inversion valve.

☐ 15. Remove the two bolts attaching the valve to the vehicle. Remove the valve.

☐ 16. Install new valve on the vehicle using the mounting bolts previously removed.

☐ 17. Connect the three air lines to the proper ports as marked during removal.

☐ 18. Check the inversion valve operation using the previous steps.

☐ 19. Set parking brakes and remove wheel blocks.

☐ 20. Record work on job ticket.

☐ 21. Turn in job ticket when finished.

☐ 22. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

______________________________

______________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE |
|---|---|---|
| | | |
| | TOTAL PARTS/MATERIALS | |

## SPECIFICATIONS CHECKED

School/Work Name ______

Address ______

Phone # ______

Date In ______

Date Out ______

## JOB TICKET

Customer Name ______

Customer Address ______

Customer Phone # ______

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ______

Services/repairs made: ______

**LABOR**

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

______ Date ______

Technician ______

Supervisor ______

**Unit 4-C, Job Ticket for Job Sheet 2**

DT:B-C-149

# Special Circuits
# Unit 4-C

## Job Sheet 3—Inspect and Test Anti-Compounding Circuit Equipped with Quick Release (QR) 1-C; Replace as Needed

Name ____________________ Attempt Number __________

Date ____________________ Overall Rating __________

| **Evaluation Criteria** | **Rating** |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Specifications are checked | ______ |
| Repair/replacements are made correctly | ______ |
| Job ticket is filled out properly | ______ |
| Cleanup is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Soap solution
6. Air brake system to be worked on
7. Others—as recommended by instructor and service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Move vehicle into the shop.

☐ 4. Apply the parking brakes.

☐ 5. Block the vehicle wheels.

**Caution: Open the air reservoir drain cocks to bleed air from the system before removing any lines or plugs.**

☐ 6. Release the parking brakes.

## Job Sheet 3

☐ 7. Remove the air line from the valve balance port.

☐ 8. Build system air pressure to 120 psi. Coat the exhaust and balance ports with a soap solution; leakage of a one-inch bubble in five seconds at either port is allowable.

☐ 9. Install the air line at the balance port.

☐ 10. Apply the parking brakes. Step on the foot brake. The QR-1C valve should exhaust air at the exhaust port.

☐ 11. Drain the air system.

☐ 12. Remove the air line from the valve supply port.

☐ 13. Build system air pressure to 120 psi, with the foot valve depressed, coat the supply port and the seam between the body and cover with a soap solution; leakage of a one-inch bubble in five seconds at the supply port is allowable. No leakage between the body and cover is permitted.

☐ 14. Install the air line at the supply port.

☐ 15. If the valve does not function properly, or if leakage is excessive, replace the valve.

☐ 16. To replace the QR-1C valve, drain the air brake system.

☐ 17. Mark and disconnect the air lines from the quick release valve.

☐ 18. Remove the mounting bolts and the valve.

☐ 19. Install the new quick release valve with the exhaust port facing down. Securely tighten the mounting bolts.

☐ 20. Connect the air lines to the quick release valve in the locations previously marked.

☐ 21. Retest new valve using the previous steps.

☐ 22. Set parking brakes and remove wheel blocks.

☐ 23. Record work on job ticket.

☐ 24. Turn in job ticket when finished.

☐ 25. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ____________________

____________________

____________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| TOTAL PARTS/MATERIALS | | | |

## SPECIFICATIONS CHECKED

| | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |

School/Work Name ________________________

Address ________________________

Phone # ________________________

Date In ____________

Date Out ____________

## JOB TICKET

Customer Name ________________________

Customer Address ________________________

Customer Phone # ________________________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ________________________

Services/repairs made: ________________________

| LABOR | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

________________________ Date ____________

Technician ____________

Supervisor ____________

**Unit 4-C, Job Ticket for Job Sheet 3**

DT:B-C-153

# Special Circuits
# Unit 4-C

## Job Sheet 4—Inspect and Test Trailer Air Supply Valve; Replace as Needed

Name ______________________ Attempt Number ______________

Date ______________________ Overall Rating ______________

| **Evaluation Criteria** | **Rating** |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Specifications are checked | ______ |
| Repair/replacements are made correctly | ______ |
| Job ticket is filled out properly | ______ |
| Cleanup is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Soap solution
6. Test air gauge installed in a spare hose coupling
7. Air brake system to be worked on
8. Others—as recommended by instructor and service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Move vehicle into the shop.

☐ 4. Apply the parking brakes.

☐ 5. Block the vehicle wheels.

**Caution: Open the air reservoir drain cocks to bleed air from the system before removing any lines or plugs.**

☐ 6. Connect the assembled hose coupling and test gauge in the tractor emergency hose coupling.

## Job Sheet 4

☐ 7. Start the engine and build up system pressure and check pressure reading on the test gauge as reservoir pressure builds up. There should be no pressure reading on the test gauge.

☐ 8. When system pressure reaches the 30 to 40 psi range on the dash gauge, make and hold a foot or hand valve application and observe that no air escapes at the open trailer service hose coupling.

☐ 9. When system pressure reaches about 60 psi the trailer air supply valve button should be pushed in. System pressure should show at once on the test gauge connected in the emergency line, and the button of trailer valve should remain in without being held.

☐ 10. Build the system pressure up to about 100 psi, then stop the engine. With the engine stopped, wait momentarily, then notice that the dash gauge and test gauge pressure readings equal. While still in this position, make a foot valve application, and observe that air is delivered out the open trailer service coupling.

☐ 11. With the trailer supply valve button still in, check for leakage at the valve exhaust and tripper exhaust ports. Leakage should not exceed a 1-inch bubble in five seconds.

☐ 12. With the trailer supply valve button still in, check for leakage at the tractor protection valve exhaust and open service coupling. Leakage should not be more than a 1-inch bubble in five seconds.

☐ 13. Pull the trailer air supply valve button out. Pressure on the test gauge connected in the emergency line should drop to zero. Make and hold a hand valve application, and observe that air delivered at the open service coupling does not exceed a 1-inch bubble in five seconds. Release the hand valve application.

☐ 14. If the trailer air supply valve does not function as desired in the above test or if leakage is excessive, replace with a new valve.

**Caution: Drain the air system before removing any lines or plugs.**

☐ 15. To replace the valve, remove the dash panel covering the valve and remove the bracket and valve from the dash structure. Lift the bracket and valve to a serviceable level.

☐ 16. Disconnect the supply and delivery lines from the valve and mark the lines.

☐ 17. Drive out the valve button spiral pin and remove the button.

☐ 18. Remove the valve mounting nuts, then remove the valve from the bracket.

☐ 19. Install a new trailer supply valve. Connect the line as marked and tighten.

☐ 20. Place the valve in the bracket mounting hole and install mounting nuts and tighten.

☐ 21. Install the button on the valve, and attach with the button spiral pin.

## Job Sheet 4

☐ 22. Install the bracket and valves in the dash. Install the dash panel.

☐ 23. Retest new valve using the previous steps.

☐ 24. Set parking brake and remove wheel blocks.

☐ 25. Record work on job ticket.

☐ 26. Turn in job ticket when finished.

☐ 27. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ____________________________________________

______________________________________________________________

______________________________________________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| **TOTAL PARTS/MATERIALS** | | | |

## SPECIFICATIONS CHECKED

| | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |

School/Work Name ______________________
Address ______________________
Phone # ______________________

Date In ____________
Date Out ____________

## JOB TICKET

Customer Name ______________________
Customer Address ______________________
Customer Phone # ______________________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ______________________

______________________

Services/repairs made: ______________________

| LABOR | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

______________________ Date ____________

Technician ____________
Supervisor ____________

Unit 4-C, Job Ticket for Job Sheet 4

DT:B-C-159

# Special Circuits
# Unit 4-C

## Job Sheet 5—Inspect and Test Trailer Brake Control Valve (Hand Valve); Replace as Needed

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

| **Evaluation Criteria** | **Rating** |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Specifications are checked | ______ |
| Repair/replacements are made correctly | ______ |
| Job ticket is filled out properly | ______ |
| Cleanup is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Soap solution
6. Air pressure test gauge
7. Air brake system to be worked on
8. Others—as recommended by instructor and service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Move vehicle into the shop.

☐ 4. Apply the parking brakes.

☐ 5. Block the vehicle wheels.

☐ 6. Release the parking brakes.

☐ 7. Connect the test gauge to the delivery port of the hand valve, or connect the gauge to the service hose coupling located behind the cab. When the gauge is connected to the service hose coupling, install a dummy hose coupling on the supply (emergency) hose coupling, and place the dash valve in the trailer charging position.

## Job Sheet 5

☐ 8. Move the handle of the hand valve to the fully applied position. The test gauge should register full reservoir pressure.

☐ 9. Upon manual release, the gauge should immediately register zero.

☐ 10. Locate the exhaust port or exhaust line and apply a soap solution.

☐ 11. With the valve in the released position, exhaust leakage should not exceed a 1-inch bubble in 5 seconds.

☐ 12. With the valve fully applied, leakage at the exhaust should not exceed a 1-inch bubble in 5 seconds.

☐ 13. If the valve does not function properly or if leakage is excessive, replace the hand valve.

**Caution: Open the air reservoir drain cocks to bleed air from the system before removing any lines.**

☐ 14. To replace the valve, remove dash cover if needed.

☐ 15. Mark the three air lines and disconnect the air lines from the valve.

☐ 16. Loosen the clamp which holds the hand valve mounting bracket to the steering column and remove valve from the steering column by sliding the bracket out of the clamp.

☐ 17. Remove the mounting bracket from the valve by removing the three Phillips screws.

☐ 18. Remove line fitting from old valve and install in new valve.

☐ 19. Install the mounting bracket on the new hand valve and securely tighten the three screws.

☐ 20. Slide the mounting bracket through the clamp on the steering column. Position the valve on the steering column and tighten the clamp firmly.

☐ 21. Using the reference marks made during removal, attach the air lines to the hand valve and tighten the lines firmly using two wrenches.

☐ 22. Install dash cover if removed.

☐ 23. Retest new hand valve using the previous steps.

☐ 24. Set parking brakes and remove wheel blocks.

☐ 25. Record work on job ticket.

☐ 26. Turn in job ticket when finished.

☐ 27. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ____________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| TOTAL PARTS/MATERIALS | | | |

**SPECIFICATIONS CHECKED**

| | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |

School/Work Name ______________________

Address ______________________

Phone # ______________________

Date In ____________

Date Out ____________

## JOB TICKET

Customer Name ______________________

Customer Address ______________________

Customer Phone # ______________________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ______________________

______________________

Services/repairs made: ______________________

| LABOR | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

______________________ Date ____________

Technician ____________

Supervisor ____________

Unit 4-C, Job Ticket for Job Sheet 5

DT:B-C-163

# Special Circuits
## Unit 4-C

### Job Sheet 6—Inspect and Test Tractor Protection Valve; Replace as Needed

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

| Evaluation Criteria | Rating |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Specifications are checked | ______ |
| Repair/replacements are made correctly | ______ |
| Job ticket is filled out properly | ______ |
| Cleanup is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Soap solution
6. Air brake system to be worked on
7. Others—as recommended by instructor and service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Move vehicle into the shop.

☐ 4. Apply the parking brakes.

☐ 5. Block the vehicle wheels.

☐ 6. Place the trailer air supply valve in the emergency position.

☐ 7. Disconnect the trailer air lines from the trailer supply and service couplings. Apply a soap solution to the couplings.

## Job Sheet 6

☐ 8. With tractor reservoirs charged to at least 100 psi, make and hold a full service brake application. Leakage at either tractor hose coupling should not exceed a 1-inch bubble in five seconds.

☐ 9. Connect the trailer supply line hose coupling, and place the trailer supply valve in the "run" position. Leakage at the service coupling should not exceed a 1-inch bubble in five seconds.

☐ 10. Connect the service brake coupling, and make and hold a full service brake application.

☐ 11. If leakage is excessive, replace the valve.

**Caution: Open the air reservoir drain cocks to bleed air from the system.**

☐ 12. To replace the valve, remove the trailer hose assemblies from the TP valve.

☐ 13. Disconnect the tractor service and supply lines and mark.

☐ 14. Remove the fasteners attaching the valve to the vehicle. Remove the valve.

☐ 15. Install new valve on the vehicle, and attach it with mounting bolts and tighten.

☐ 16. Connect lines to valve as marked and tighten.

☐ 17. Close the drain cocks to the air reservoirs.

☐ 18. Start engine and build system air pressure to 120 psi.

☐ 19. Retest new valve by using the previous steps.

☐ 20. Set parking brakes and remove wheel blocks.

☐ 21. Record work on job ticket.

☐ 22. Turn in job ticket when finished.

☐ 23. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ____________________________________________

______________________________________________________________

______________________________________________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| TOTAL PARTS/MATERIALS | | | |

## SPECIFICATIONS CHECKED

| | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |

School/Work Name ____________________

Address ____________________

Phone # ____________________

Date In ____________

Date Out ____________

## JOB TICKET

Customer Name ____________________

Customer Address ____________________

Customer Phone # ____________________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ____________________

____________________

Services/repairs made: ____________________

____________________

____________________

____________________

____________________

____________________

____________________

____________________

____________________

____________________

____________________

| LABOR | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

____________________ Date ____________

Technician ____________

Supervisor ____________

Unit 4-C, Job Ticket for Job Sheet 6

DT:B-C-167

## Special Circuits
## Unit 4-C

### Job Sheet 7—Check Operation of Parking Brake; Remove, Inspect, and Replace Parking Brake (Spring Brake) Chamber as Needed

Name ______________________ Attempt Number ______________

Date ______________________ Overall Rating ______________

| Evaluation Criteria | Rating |
|---|---|
| Directions are followed | ______ |
| Safety procedures are followed | ______ |
| Service manual is used properly | ______ |
| Parts are inspected accurately | ______ |
| Specifications are checked | ______ |
| Repair/replacements are made correctly | ______ |
| Job ticket is filled out properly | ______ |
| Cleanup is adequate | ______ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Jack and safety stands
6. Soap solution
7. Air brake system to be worked on
8. Others—as recommended by instructor and service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Move vehicle into the shop.

☐ 4. Apply the parking brakes.

☐ 5. Block the vehicle wheels.

☐ 6. Inspect brake chamber operation and check for air leakage.

☐ 7. Start engine and charge the air system to the compressor governor valve cut-out point.

## Job Sheet 7

☐ 8. Stop the engine and release the parking brakes.

☐ 9. Have an assistant apply and hold the brake pedal.

☐ 10. Apply a soap solution around the air brake chamber clamp and breather holes.

☐ 11. Verify that no bubbles appear.

☐ 12. If the bubbles appear, overhaul or replace the rear air brake chamber.

☐ 13. Remove rear brake chamber.

☐ 14. Raise the vehicle and support with safety stands.

☐ 15. Cage the power spring on the parking (spring) brake chamber.

  ☐ a. Remove plug from the release tool keyhole in the center of the spring brake chamber.

  ☐ b. Remove the release tool assembly from the side pocket of the adapter.

**Caution: Do not attempt to cage the power spring when the rear air brake chamber shows structural damage. Caging the power spring or disassembly of the spring brake chamber may result in the forceful release of the power spring and the chamber contents which may cause severe personal injury. Remove the entire rear air brake chamber if it has structural damage and replace with a new unit.**

☐ 16. With the parking brakes released, insert the release stud through the keyhole in the rear air brake chamber. Bottom out stud and turn the release stud 90° (1/4" turn) clockwise.

☐ 17. Pull on the release stud to ensure the release stud crosspin is properly seated in the pressure plate. Assemble the release stud washer and nut on the release stud finger tight.

☐ 18. Measure the release stud length beyond the release stud nut. Check service manual for correct length.

**Caution: Do not over torque the stud nut.**

☐ 19. Fully release the air brake automatic slack adjuster and remove air brake chamber clevis pins.

☐ 20. Drain air from air stands and disconnect air lines from the brake chamber.

## Job Sheet 7

☐ 21. Remove mounting nuts and washer from the rear air brake chamber and remove chamber.

☐ 22. Disassemble brake chamber to replace service brake diaphragm and install new spring brake chamber. Check with instructor before disassembly.

☐ 23. Mark the adapter and service hosing in relation to the clamp ring assembly.

☐ 24. Pull out the push rod and clamp it using locking-type pliers.

☐ 25. Remove nuts and bolts on clamp ring assembly and remove clamp ring.

☐ 26. Remove diaphragm and spring brake chamber.

☐ 27. Clean and inspect parts for rust and cracks.

**Caution: Never disassemble the spring brake assembly; always replace with a new assembly.**

☐ 28. Install new service brake diaphragm and new spring brake assembly.

☐ 29. Install clamp ring assembly and torque nuts and bolts.

☐ 30. Remove locking-type pliers.

☐ 31. Install brake chamber to the chamber/camshaft support bracket.

☐ 32. Install mounting washer and nuts to the rear air brake chamber and torque (80 lb.-ft.).

☐ 33. Install air brake chamber clevis pins and connect air lines.

☐ 34. Adjust slack adjuster to adjust the brakes.

☐ 35. Start the engine and charge the system to the air compressor governor valve cut-out point and release the parking brakes; stop engine.

☐ 36. Uncage the spring brake, and unscrew the release stud nut and washer from the release stud.

☐ 37. Turn the release stud one-quarter turn counter-clockwise and remove it from the keyhole and install in the storage pocket. Install dust plug into the keyhole.

☐ 38. Remove safety stands and lower vehicle.

☐ 39. Check for proper brake operation and leaks.

☐ 40. Set parking brakes and remove wheel blocks.

## Job Sheet 7

☐ 41. Record work on job ticket.

☐ 42. Turn in job ticket when finished.

☐ 43. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

______________________________

______________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE | |
|---|---|---|---|
| | | | |
| | TOTAL PARTS/MATERIALS | | |

### SPECIFICATIONS CHECKED

| | |
|---|---|
| | |

School/Work Name ____________________
Address ____________________
Phone # ____________________

Date In ____________
Date Out ____________

## JOB TICKET

Customer Name ____________________
Customer Address ____________________
Customer Phone # ____________________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ____________________

Services/repairs made: ____________________

| LABOR | |
|---|---|
| | |

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

____________________ Date ____________

Technician ____________
Supervisor ____________

Unit 4-C, Job Ticket for Job Sheet 7

# Trailer Air Brake Systems
# Unit 5-C

## Objective Sheet

### Unit Objective

After completing this unit, the student should be able to service special circuits and their components. The student should demonstrate these competencies by completing the assignment sheet and job sheets and by scoring a minimum of 85 percent on the written test.

### Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to trailer air brake systems with their definitions.
2. Describe two types of gladhands.
3. Identify components of the trailer air brake system.
4. Match components of the trailer air brake system with their functions.
5. Identify components of the dollie system.
6. Identify components of the trailer full function valve system.
7. Identify the ports of a full function valve.
8. Identify and connect components of a trailer full function air brake system. (Assignment Sheet 1)
9. Inspect and test tractor trailer gladhands; repair or replace as needed. (Job Sheet 1)
10. Inspect and test trailer brake full function valve; replace as needed. (Job Sheet 2)

# Trailer Air Brake Systems
## Unit 5-C

### Information Sheet

1. **Terms and definitions**

    a. **Converter dollie**—An axle, frame, drawbar, and fifth wheel arrangement that converts a semitrailer into a full trailer

    b. **Full function valve**—Provides control over spring brakes (apply and release) and service brake

    c. **Gladhand**—Special connector between tractor and trailer air line that provides a good seal while allowing ease of connection and disconnection

    d. **Jackknife**—To turn and rise to form an angle of 90 degrees or less with each other

    e. **Jumbo reservoir**—Holds pressurized air supplied from the tractor; has same volume as two standard reservoirs

    f. **Multi-function valve**--Provides control over spring brakes (apply and release)

    g. **Trailer air supply valve**—Provides driver control over the flow of air to the trailer

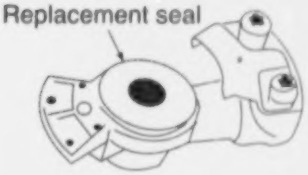
    h. **Trailer emergency (supply) line**—Provides air pressure to charge the trailer reservoir from the tractor primary service reservoir

    Note: This line is connected on one end to the tractor protection valve and is equipped with a gladhand at the other end.

    i. **Trailer service line**—Provides regulated pressure to the trailer brake relay valve to provide proportional braking between the tractor and trailer

2. **Types of gladhands and their functions**

Figure 1—Aluminum gladhand



a. **Emergency**—Supplies emergency air to trailer; identified by red color or "emergency" will be written on it

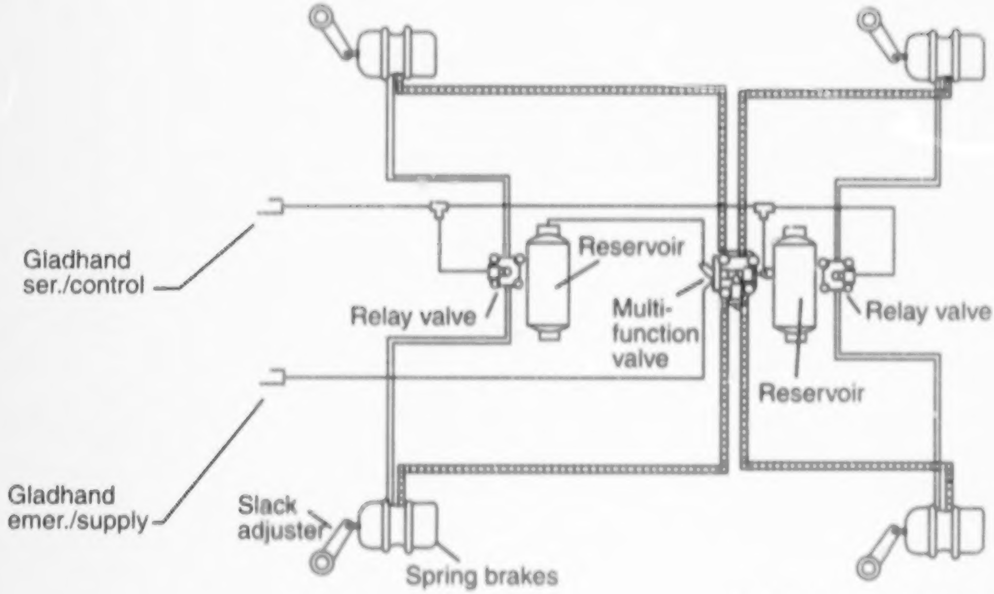
b. **Service**—Sends signal to relay to apply brakes; identified by blue color or "service" will be written on it

Note: The trailer parking brakes will not release if emergency line is disconnected.

## Information Sheet

### 3. Components of the trailer air brake system

Figure 2


Gladhand
ser./control
Reservoir
Relay valve
Multi-
function
valve
Relay valve
Reservoir
Gladhand
emer./supply
Slack
adjuster
Spring brakes

Courtesy of Haldex Midland Services

### 4. Functions of the components of the trailer air brake system

a. **Multi-function valve**—Controls the spring brake

Note: The trailer spring brake is identical to the tractor spring brake, but has only been equipped on trailers with 121 law.

b. **Relay valve**—Provides air supply and releases air from service brakes

c. **Gladhands**—Allow for quick connection/disconnection between the tractor's air lines and the trailer's air lines

d. **Reservoirs**—Store the air reserve for service brakes

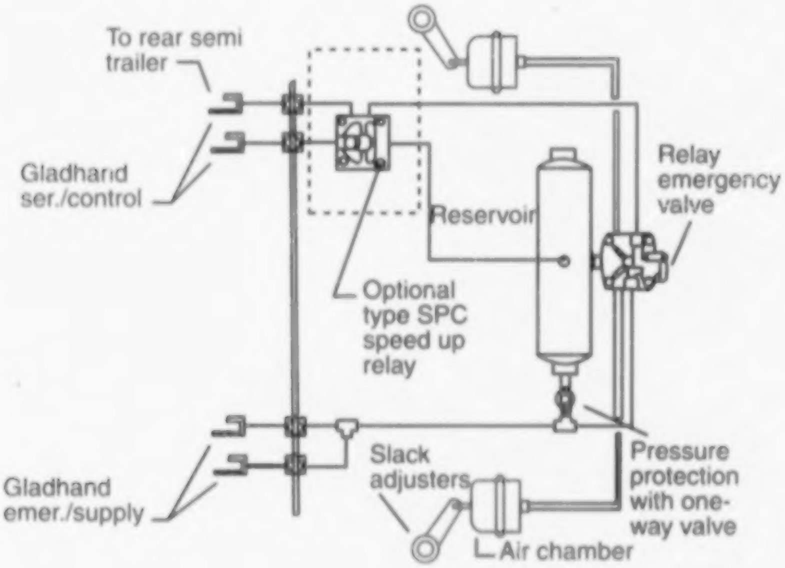
e. **Spring brakes**—House service brake chamber and park and emergency brake unit

f. **Slack adjuster**—Provides a means of adjusting clearance between brake shoe and drum to compensate for lining wear

## Information Sheet

### 5. Components of the dollie system

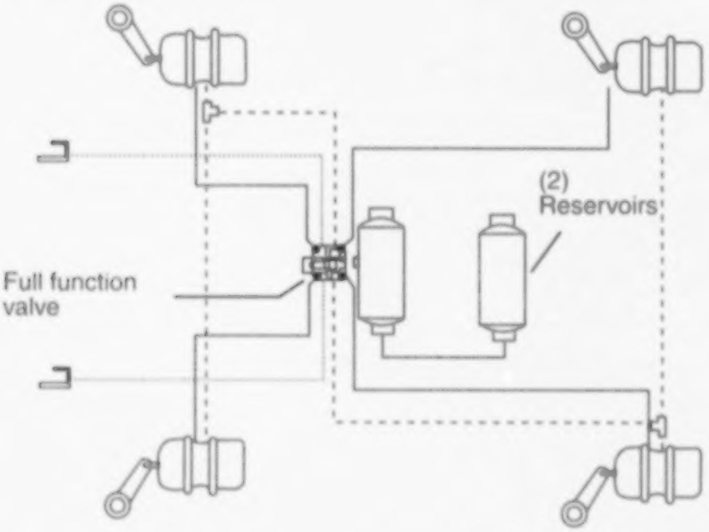
Figure 3


To rear semi trailer
Gladhand ser./control
Reservoir
Relay emergency valve
Optional type SPC speed up relay
Gladhand emer./supply
Slack adjusters
Pressure protection with one-way valve
Air chamber

Courtesy of Haldex Midland Services

### 6. Components of the trailer full function valve system

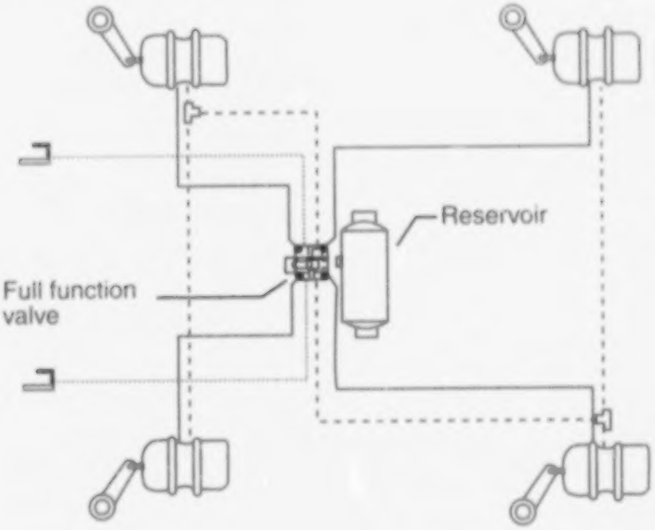
Figure 4—Two Tank


(2) Reservoirs
Full function valve

Courtesy of Haldex Midland Services

## Information Sheet

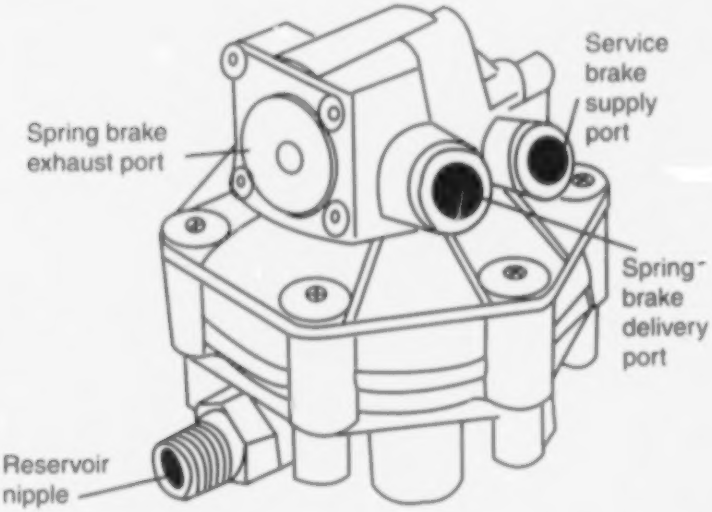
Figure 5—Jumbo Tank


Reservoir
Full function valve

Courtesy of Haldex Midland Services

7. **Ports of a full function valve**

Figure 6


Service brake supply port
Spring brake exhaust port
Spring brake delivery port
Reservoir nipple

Courtesy of Haldex Midland Services

# Trailer Air Brake Systems
## Unit 5-C

### Student Supplement 1—Trailer Systems Troubleshooting Guide

Note: This troubleshooting guide is courtesy of Haldex Midland Services.

## HOW TO USE THIS CHART

The purpose of the chart is to help you solve a specific problem in the pneumatic portion of a trailer air brake system with the assumption the foundation brake components and tractor pneumatics are in good repair.
Identify which system is malfunctiong. (Refer to how to check your system).
Identify your system from the schematics shown.
Identify the problem and select the solution recommended for that system.
CAUTION: WHEELS MUST BE BLOCKED.
CAUTION: SPRING BRAKE INSPECTION AND DISASSEMBLY MUST BE IN ACCORD WITH THE MANUFACTURER'S.

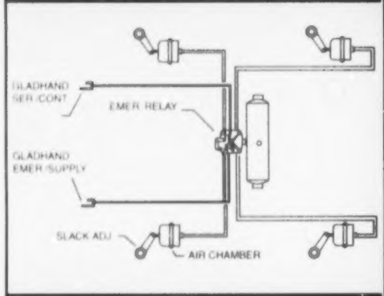
## HOW TO CHECK YOUR SYSTEM

The most important factor in trailer troubleshooting is to determine if the malfunction is in the vehicle's "parking brake system" or the "service brake system". If the problem is "Neither air system is working", the fault may be mechanical.
All "Pre-121" or new "121" trailers have a "parking/emergency system" and a normally used "service brake system". The parking system works from the emergency (supply) line. The service system works from the service (control) line.
You can determine if the parking/emergency brakes operate by changing and then disconnecting the tractor emergency (supply) line.
The service brakes will operate with apply and release air in the service (control) line by the tractor hand control or foot control valve.

## HOW TO IDENTIFY YOUR SYSTEM

All types of trailer air brake systems can be identifed for troubleshooting purposes by starting from the brake chamber or spring brake assembly. This procedure will work for older "Pre-121" equipped trailers regardless of how many tanks and valves, or types of valves that you see.
If your trailer is equipped with chambers only–you are dealing with a system "A" for a trailer and systems "C" and "D" for a converter dolly. A "four-wheel" trailer may have chambers on the steerable axle—identify axle as a dolly system "C" or "D".
If the vehicle is equipped with spring brakes you must determine which hose is the "parking/emergency" and which is the "service".
Follow the service hose from the service portion of the spring brake assembly. The hose will be connected to the service relay valve and it is responsible for the application and release of the service brake only.
Follow the parking/emergency hose from the spring brake assembly and you will end up at the spring brake control valve.
After you have identified your system, go directly to the Problem and Solution Sections on the reverse side to remedy your situation.

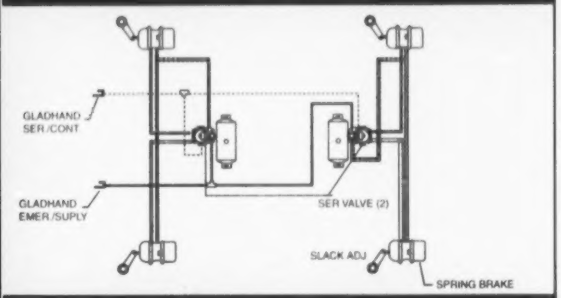
SYSTEM A
PRE-121 RELAY/EMERGENCY VALVE SYSTEM


GLADHAND SER./CONT.
EMER. RELAY
GLADHAND EMER./SUPPLY
SLACK ADJ
AIR CHAMBER

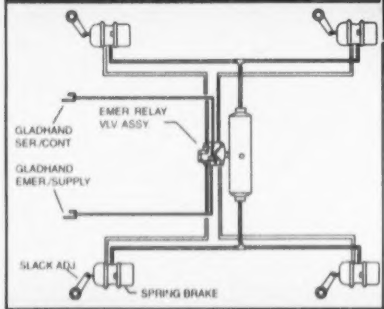
## Haldex Midland Services

## TRAILER SYSTEMS TROUBLESHOOTING GUIDE

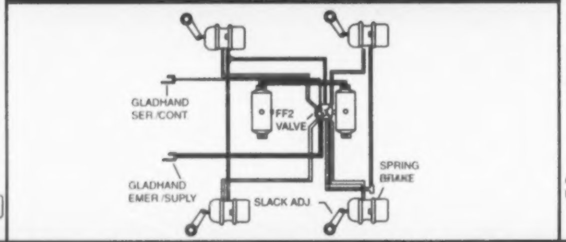
SYSTEM F
TANDEM AXLE SYSTEM WITH SERV VALVES


GLADHAND SER./CONT.
GLADHAND EMER./SUPLY
SER VALVE (2)
SLACK ADJ
SPRING BRAKE

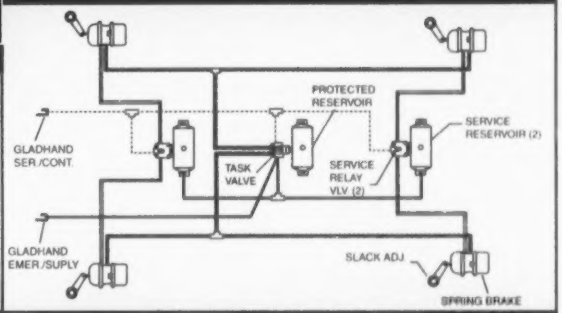
SYSTEM B
PRE-121 RELAY/EMERGENCY VALVE SYSTEM WITH SPRING BRAKES


EMER RELAY VLV ASSY
GLADHAND SER./CONT.
GLADHAND EMER./SUPPLY
SLACK ADJ
SPRING BRAKE

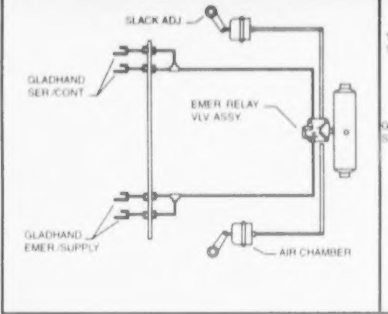
SYSTEM J
TWO TANK - ONE VALVE TANDEM AXLE SYSTEM


GLADHAND SER./CONT.
FF2 VALVE
SPRING BRAKE
GLADHAND EMER./SUPLY
SLACK ADJ

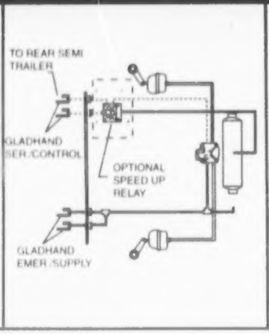
SYSTEM G
THREE TANK - THREE VALVE TANDEM SYSTEM WITH BERG TASK VALVE OR BW SR2


PROTECTED RESERVOIR
SERVICE RESERVOIR (2)
GLADHAND SER./CONT.
TASK VALVE
SERVICE RELAY VLV (2)
GLADHAND EMER./SUPLY
SLACK ADJ
SPRING BRAKE

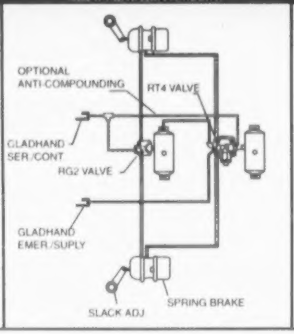
SYSTEM C
SINGLE AXLE DOLLY SYSTEM WITH CHARGING TYPE RELAY/EMERGENCY VALVE


SLACK ADJ
GLADHAND SER./CONT.
EMER. RELAY VLV ASSY
GLADHAND EMER./SUPPLY
AIR CHAMBER

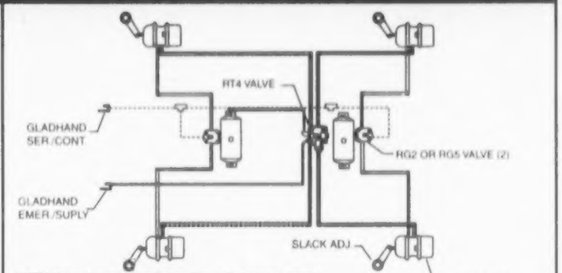
SYSTEM D
TYPICAL 121 DOLLY SYSTEM WITH NON-CHARGING TYPE RELAY/EMERGENCY VALVE


TO REAR SEMI TRAILER
GLADHAND SER./CONTROL
OPTIONAL SPEED UP RELAY
GLADHAND EMER./SUPPLY

SYSTEM E
TWO-TANK - TWO VALVE SINGLE AXLE SYSTEM WITH MIDLAND RT4/RG2 VALVE OR SEALCO MULTI FUNCTION & RELAY


OPTIONAL ANTI-COMPOUNDING
RT4 VALVE
GLADHAND SER./CONT.
RG2 VALVE
GLADHAND EMER./SUPLY
SPRING BRAKE
SLACK ADJ

SYSTEM H
TWO TANK - THREE VALVE TANDEM SYSTEM MIDLAND RT4/RG2 (RG5) VALVES OR SEALCO MULTI FUNCTION WITH SERVICE RELAY VALVE


RT4 VALVE
GLADHAND SER./CONT.
RG2 OR RG5 VALVE (2)
GLADHAND EMER./SUPLY
SLACK ADJ
SPRING BRAKE

NOTE: Procedures suggested on this wall chart are merely suggested and should not be construed to be all inclusive nor should the schematics be regarded as typical of piping patterns on all vehicles.

BEST COPY AVAILABLE

## Student Supplement 1

| PROBLEM | SYSTEM LETTER AND SOLUTION NUMBER | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G | H | J |
| **AIR LEAK AT** | | | | | | | | | |
| • Service Brake Chamber | 1-2-34 | — | 1-2-34 | 1-2-34 | — | — | — | — | — |
| • Spring Brake with service Brakes Released & Park Brake Applied | — | 11-36-37 | — | — | — | 11-36-37 | — | — | — |
| • Spring Brake with Service Brakes Released & Spring Brake Released | — | 6-11-36 or 37 | — | — | 6-11-36 or 37 | 6-11-36 or 37 | 6-11-36 or 37 | 6-11-36 or 37 | 6-11-36 or 37 |
| • Spring Brake with Service Brakes Applied & Spring Brake Released | — | 6-25-36 | — | — | 6-25-36 | 6-25-36 | 6-25-36 | 6-25-36 | 6-25-36 |
| • Emergency Relay Valve with Service Brake Applied or Released | 42 | 33-36-37 or 37 | 42 | 51 | — | — | — | — | — |
| • Emergency Relay Valve with Emergency Brake Applied | 42 | 42 | 42 | 51 | — | — | — | — | — |
| • Service Relay Valve with Service Brake Released & Spring Brake Applied | — | — | — | — | 38 | — | 38 | 38 | 53 |
| • Service Relay Valve with Service Brake Released & Spring Brake Released | — | — | — | — | 33-38 | — | 33-38 | 33-38 | 33-53 |
| • Service Relay Valve with Service Brake Applied & Spring Brake Released | — | — | — | — | 38 | — | 38 | 38 | 53 |
| • Spring Brake Control Valve with Spring Brake Applied or Released | — | — | — | — | 40 | — | 39 | 40 | 53 |
| • Trailer Service Gladhand on Disconnect (with Trailer Supply Pressurized) | 42 | 42 | 42 | 51 | 24-40 | 43 | 24-39 | 24-40 | 24-53 |
| • Trailer Emergency Gladhand on Disconnect | 42 | 42 | 42 | 51 or 52 | — | 43 | 32 | — | — |
| • Trailer System Leakage Exceeds 2 p.s.i. per min. with Service Brakes Applied | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| • SERV. Valve with Service Brake Released & Park Brake Applied | — | — | — | — | — | 43 | — | — | — |
| • SERV. Valve with Service Brake Released & Park Brake Released | — | — | — | — | — | 33-43 | — | — | — |
| • SERV. Valve with Service Brake Applied & Park Brake Released | — | — | — | — | — | 43 | — | — | — |
| **SYSTEM OR COMPONENT FAILURE** | | | | | | | | | |
| • Trailer Brakes Slow and Sluggish | 3-4-22-44-45-46-47 | 3-4-22-44-45-46-47 | 3-4-22-44-45-46-47 | 3-4-22-44-45-46-47 | 3-4-22-44-45-46-47 | 3-4-22-44-45-46-47 | 3-4-22-44-45-46-47 | 3-4-22-44-45-46-47 | 3-4-22-44-45-46-47 |
| • Trailer Brakes Drag | 3-4-13-22-23-42 | 3-4-22-23-27 | 3-4-22-23-42 | 3-4-22-23-51 | 3-4-13-22-23-27-37 | 3-4-13-22-23-27-37 | 3-4-13-22-23-27-37 | 3-4-13-22-23-27-37 | 3-4-13-22-23-27-37 |
| • Trailer Brakes Won't Apply (Service) | 3-4-14-16-18-19 | 3-4-14-16-18-19 | 3-4-14-16-18-19 | 3-4-14-14-18-19 | 3-4-14 15-16-19 | 3-4-14-15-16-19 | 3-4-14-15-16-19 | 3-4-14-15-16-19 | 3-4-14 15-16-19 |
| • Trailer Emergency Application Too Slow | 22-28 | 22-28 | 22-28 | 22-28 | 22-28 | 22-28 | 22-28 | 22-28 | 22-28 |
| • Park/Emer Brakes Won't Release | 7-17-18-19-22-42 | 7-11-17-18-19-22-42 | 7-17-18-19-22-42- | 7-17-18-19-22-51 | 7-11-17-19-22 40 | 7-11-17-19-22-43 | 7-11-17-19-22-39 or 40 | 7-11-17-19-22-40 | 7-11-13-17-19-22-53 |
| • Park/Emer Brakes Won't Hold | 3-4-19 | 3-4-36 or 37 | 19-32 | 19-32 | 3-4-36-or 37 | 3-4-36-or 37 | 3-4-36-or 37 | 3-4-36-or 37 | 3-4-36-or 37 |
| • Park/Emer Brakes Won't Apply | 4-12-19-42 | 4-12-19-36 or 37 42 | 4-12-19-42 | 4-12-19-51 | 4-10-12-36 or 37 40 | 4-10-19-36 or 37 43 | 4-10-12-36 or 37 39 | 4-10-12-36 or 37 40 | 4-10-12-36 or 37 53 |
| • Air Reservoir Leaks or Loose Mounting | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| **BRAKE BALANCE** | | | | | | | | | |
| • Semi-Trailer "RUNS-UP" on Tractor | 4-22-45-46-47-49 | 4-22-45-46-47-49 | 4-22-46-47-49 | 4-22-46-47-49 | 4-22-45-46-47-49 | 4-22-45-46-47-49 | 4-22-45-46-47-49 | 4-22-45-46-47-49 | 4-22-45 46-47-49 |
| • Uneven Brakes | 3-4-22-31-49 | 3-4-22-31-49 | 3-4-22-31-49 | 3-4-22-31-49 | 3-4-22 31-49 | 3-4-22-31-49 | 3-4-22-31-49 | 3-4-22-31-49 | 3-4-22 31-49 |
| • Trailer Brake Lining Wear Excessive | 45-50 | 27-44-50 | 44-50 | 44 | 27-44-50 | 27-44-50 | 27-44-50 | 27-44-50 | 27-44-50 |
| •Trailer Brake Lining Wear Insufficient When Compared to Tractor | 4-16-45-46-47-49 | 4-16-45-46-47-49 | 4-17-45-46-47-49 | 4-16-45-46-47-49 | 4-16-45-46-47-49 | 4-16-45-46-47-49 | 4-16-45-46-47-49 | 4-16-45-46-47-49 | 4-16-45-46-47-49 |
| • Trailer Brakes Slow to Apply | 4-19-22-46-47 | 4-19-22-46-47 | 4-19-22-46-47 | 4-19-22-46-47 | 4-19-22-46-47 | 4-19-22-46-47 | 4-19-22-46-47 | 4-19-22-46-47 | 4-19-22-46-47 |
| • Trailer Brakes Slow to Release | 8-22-42-47-48 | 8-22-42-47-46 | 8-22-42-47-48 | 8-22-47-48-51 | 8-22-38 47-48 | 8-22-43-47-48 | 8-22-38-47-48 | 8-22-38-47-48 | 8-22-38 47-48 |
| • Damaged Foundation Components Due to Brake Compounding | — | 29 | — | 24 | 24 | — | 24 | 24 | 24 |

**ANOTHER PRODUCT FROM:**

**HEAVY DUTY GROUP**
**HEADQUARTERS**
**10930 N. Pomona Avenue**
**Kansas City, Missouri 64153-1297**
**(816) 891-2470**
**Fax: (816) 891-9447**

**HEAVY DUTY GROUP**
**DISTRIBUTION CENTER**
**8600 NE Underground Drive, Pillar #203**
**Kansas City, Missouri 64161-9763**
**(800) 643-2374   (816) 454-2426**
**Fax: (816) 454-2270**

**2/96 25M COV L20049**

BEST COPY AVAILABLE

## Student Supplement 1

# SOLUTION

1. Check service chamber at clamp housing push rod for damage.
2. Check service chamber diaphragm for rupture.
3. Check slack adjuster and chamber/spring brake push rod alignment for interference.
4. Assure slack adjuster and chamber/spring brake push rod angle 90° applied with proper adjustment.
5. Check all lines, valves, reservoirs, actuators for leakage.
6. Check spring brake for damage or loose clamp.
7. Assure jumper hoses are not crossed.
8. Assure functional return spring in service chamber or spring brake.
9. Assure air chamber size and slack adjuster arm length to original spec.
10. Assure spring brake control port has exhausted.
11. Check for ruptured spring brake diaphragm (furthest from slack adjuster).
12. Supply/emergency line must be at atmosphere.
13. Assure emergency line exceeds 100 psi pressure: check and maintain governor at max cut-in.
14. Assure air delivery to service gladhand.
15. Assure air delivery to service relay valve control port.
16. Assure air delivery to air chamber or spring brake.
17. Assure air delivery to emergency gladhand exceeds 100 psi.
18. Assure air delivery to emergency relay valve emergency port.
19. Assure air delivery to all reservoirs at system working pressure.
20. Assure air delivery to spring brake control valve control port.
21. Assure air delivery to control port on spring brake (port furthest from slack adjuster).
22. Assure open lines — no kinks, bends, closed shut-off cocks, restriction, excessive elbows.
23. Check for trapped service air pressure at trailer service/delivery hoses. If air pressure is noted, check for full release of all application valves (tractor/truck/trailer).
24. Trailer brakes which have a spring brake control valve can be compounded by the tractor air brake system. The compounding occurs when service air pressure is trapped in the trailer service line by the tractor protection valve when the supply line is released to atmosphere. Compounding is prevented by connecting the trailer service line to the appropriate port of the trailer spring brake control valve through a tee. Early spring brake control valve are equipped with a shuttle valve between the supply and service connections at the cover. The RT-4 has a one way check valve which prevents supply pressure form entering the service line: but will allow service pressure to vent at trailer supply coupling. Systems A, B, C, D, and F will not compound the trailer brake system if connected as shown on this chart.
25. Check for ruptured service brake diaphragm in spring brake (clamp nearest slack adjuster) after attention to damage or loose clamps.
26. Proceed same as for service-relay valve.
27. Assure spring brake is fully released with supply air at system pressure above 100 PSI on emergency side of spring brake.
28. Excessive volume imposed in supply/emergency line—ie: air pintle air chamber.
29. On a pre-121 exempt trailer utilizing an emergency relay valve, the spring brake emergency port should be plumbed directly to the tank.
30. Observe and determine which specific device, fitting or hose is leaking and replace.
31. Assure a leak free system by applying service brake and inspecting.
32. Note that some trailers may have the emergency/supply line piped to a single check valve at both tanks — one could be leaking.
33. Check for failure in spring brake center seal.
    A Block wheels and release park brake.
    B Check for air pressure leakage at service port of each spring brake until the leaking assembly is located. Replace leaking unit.
    C If no spring brake leakage is found see #41.
34. Confirm and replace with Type 30 diaphragm, N20130F; air chamber Type 30, KN36300.
35. Confirm and replace/use rubber grommets with integral brackets.
36. Confirm and replace with appropriate spring brake assembly; Type 30/30, 15431 or Type 24/30, 15425. Diaphragm Type 24/30 piggy back 15427.
37. Confirm and replace with Type 30/30 piggy back 15435, or Type 24/30 piggy back 15427.
38. Confirm and replace with service relay valve. KN28550 (1/2 supply) or KN28551 (3/8 supply).
39. confirm and replace with task spring brake control valve 12360.
40. Confirm and replace with RT4 spring brake control valve KN26000 (replaces Sealco ratio valves).
41. Assure adequate trailer brake function.
42. Confirm and replace with emergency relay valve, A71890 (1/4 Del.) or A99036 (3/8 Del.).
43. Confirm and replace with FFV (Full Function Valve) System.
44. Assure adequate tractor brake function.
45. Assure adequate pressure and timing balance relative to tractor/trailer application.
46. consider addition of "FAB Valve" to accelerate trailer timing.
47. Consider used of "jumper hose analyzer" and duplex gauge to pin-point brake imbalance.
48. Assure full mechanical release — foundation brake.
49. Assure "push-out" pressure or initial slack adjuster motion at 3 to 7 psi — at all brakes.
50. Proceed per problem "trailer brakes drag."
51. Confirm and replace with emergency relay valve (non-charging), A71891 or A71892.
52. Confirm and replace with pressure protection valve with one-way check, A80570 (50 psi) or A80571 (75 psi).
53. Confirm and replace with full function valve (FFV) KN28600 (3/4 Resv) or KN28601 (1/2 Resv).

NOTE: FOR FURTHER TECHNICAL ASSISTANCE CONTACT YOUR MIDLAND DISTRIBUTOR, DISTRICT MANAGER, A TASK TEAM MEMBER OR CALL 800-643-2374 AND ASK FOR APPLICATION SPECIALIST.

BEST COPY AVAILABLE

# Trailer Air Brake Systems
# Unit 5-C

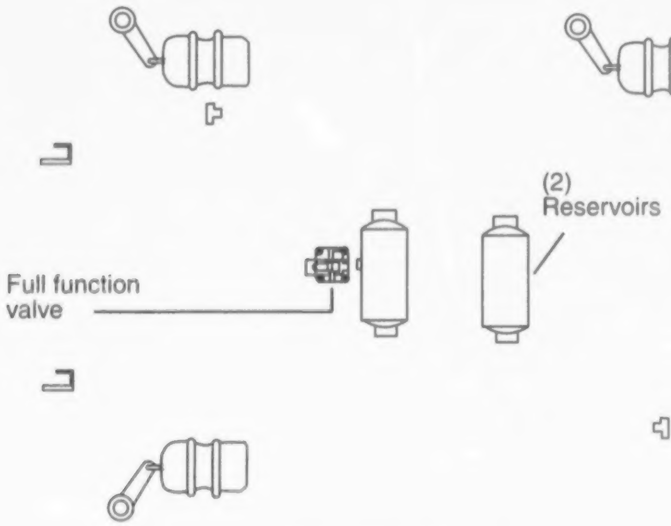
## Assignment Sheet 1—Identify and Connect Components of a Trailer Full Function Air Brake System

Name ______________________________ Overall Rating ____________

| **Evaluation Criteria** | **Rating** |
|---|---|
| Components are correctly identified | ______ |
| Components are correctly connected | ______ |

Directions: Shown below are the components that make up the trailer full function air brake system. Identify each component and then draw lines that connect the components for the trailer brake system.

Figure 1



Two Tank FFV

Courtesy of Haldex Midland Services

# Trailer Air Brake Systems
## Unit 5-C

### Job Sheet 1—Inspect and Test Tractor Trailer Gladhands; Repair or Replace as Needed

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

| **Evaluation Criteria** | **Rating** |
|---|---|
| Directions are followed | ________ |
| Safety procedures are followed | ________ |
| Service manual is used properly | ________ |
| Parts are inspected accurately | ________ |
| Specifications are checked | ________ |
| Repair/replacements are made correctly | ________ |
| Job ticket is filled out properly | ________ |
| Cleanup is adequate | ________ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Soap solution
6. Air brake system to be worked on
7. Others—as recommended by instructor and service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Move vehicle into the shop.

☐ 4. Apply the parking brakes.

☐ 5. Block the vehicle wheels.

☐ 6. Pull trailer air supply valve out to discharge air pressure from trailer hoses.

☐ 7. Uncouple both service and emergency gladhands and inspect the packing rings for damage, deterioration, or lack of resilience.

☐ 8. Inspect the ramps on the gladhands for damage.

## Job Sheet 1

☐ 9. Couple both service and emergency gladhands. To couple the two gladhands together, hold them about 25° opposite each other while starting both guides into the locking arm. Next rotate them until they come to rest against the limiting pin.

☐ 10. Start the vehicle and build the brake system to cut-out pressure, 120 psi. Push in trailer air supply valve to charge trailer air system. Release parking brakes.

☐ 11. Have a helper apply maximum service brake application with foot valve and hold.

☐ 12. While holding a full service brake application, apply a soap solution around both sets of gladhands and check for leaks.

☐ 13. If air leakage is present, replace packing rings in gladhand.

**Caution: Pull trailer supply valve to discharge air from the trailer hoses.**

☐ 14. To install new packing rings, uncouple gladhands and take a small screwdriver and pry packing ring from gladhand.

Note: Make sure and install new packing ring of same type.

☐ 15. Push ring in with fingers and lubricate.

☐ 16. Test gladhands using previous steps.

☐ 17. Set parking brakes and remove wheel blocks.

☐ 18. Record work on job ticket.

☐ 19. Turn in job ticket when finished.

☐ 20. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

______________________________

______________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| **TOTAL PARTS/MATERIALS** | | | |

## SPECIFICATIONS CHECKED

| | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |

School/Work Name ____________________

Address ____________________

Phone # ____________________

Date In ____________

Date Out ____________

## JOB TICKET

Customer Name ____________________

Customer Address ____________________

Customer Phone # ____________________

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ____________________

Services/repairs made: ____________________

| LABOR | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

____________________ Date ____________

Technician ____________

Supervisor ____________

Unit 5-C, Job Ticket for Job Sheet 1

DT:B-C-189

# Trailer Air Brake Systems
# Unit 5-C

## Job Sheet 2—Inspect and Test Trailer Brake Full Function Valve; Replace as Needed

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

| **Evaluation Criteria** | **Rating** |
|---|---|
| Directions are followed | ________ |
| Safety procedures are followed | ________ |
| Service manual is used properly | ________ |
| Parts are inspected accurately | ________ |
| Specifications are checked | ________ |
| Repair/replacements are made correctly | ________ |
| Job ticket is filled out properly | ________ |
| Cleanup is adequate | ________ |

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Tools and materials

1. Technician's common hand tools
2. Appropriate service manual
3. Job ticket or work order—one is included or use appropriate one provided at your facility
4. Wheel blocks
5. Soap solution
6. Air brake system to be worked on
7. Others—as recommended by instructor and service manual

B. Procedure

☐ 1. Locate and follow the appropriate procedure in the service manual.

☐ 2. Complete the accompanying job ticket with all pertinent information.

☐ 3. Move vehicle into the shop.

☐ 4. Apply the parking brakes.

☐ 5. Block the vehicle wheels.

☐ 6. Start the vehicle and build the brake system to cut-out pressure, 120 psi. Push in trailer air supply valve to charge trailer air system. Release parking brakes.

☐ 7. Make several service brake applications and check for prompt application and release of trailer brakes inspecting the operation of the trailer full function relay valve. Check service manual for specifications.

## Job Sheet 2

☐ 8. With the service brakes released, apply a soap solution to the exhaust port of the trailer full function valve and check for excessive leakage.

☐ 9. While holding a full service brake application, apply a soap solution to the exhaust port and check for air leaks.

☐ 10. Check with instructor and record findings on work order. If valve did not pass tests continue.

**Caution: Open the air reservoir drain cocks to bleed air from the system before removing any lines or plugs.**

☐ 11. Remove all air hoses from the valve, cap the hoses, and mark them for reassembly.

☐ 12. Remove the valve mounting bolts and remove the valve.

☐ 13. Replace old valve mounting bolts and remove the valve.

☐ 14. Attach the new valve to the trailer using the bolts, washers, and nuts; torque to specifications.

☐ 15. Connect the air hose fittings to the valve ports. Check service manual for tightening.

☐ 16. Check with your instructor and continue.

☐ 17. Close air reservoir drain cocks and start the vehicle engine to pressurize the air system.

☐ 18. Test valve operation using previous steps.

☐ 19. Set parking brakes and remove wheel blocks.

☐ 20. Record work on job ticket.

☐ 21. Turn in job ticket when finished.

☐ 22. Clean work area and return tools and materials to proper storage.

Evaluator's Comments: ____________________________________________

______________________________________________________________

______________________________________________________________

## PARTS LIST

| QTY. | PARTS/MATERIALS | PRICE | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | TOTAL PARTS/MATERIALS | | |

### SPECIFICATIONS CHECKED

| | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |

School/Work Name ______

Address ______

Phone # ______

Date In ______

Date Out ______

## JOB TICKET

Customer Name ______

Customer Address ______

Customer Phone # ______

| Vehicle/Equip. | Make & Model | License #/Motor #/Serial # | Speedometer |
|---|---|---|---|
| | | | |

Condition reported by customer/service requested: ______

Services/repairs made: ______

| LABOR | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

**Customer Authorization**

I, the undersigned, have reviewed the required service and parts estimates and authorize this maintenance to be performed with the understanding that I will be notified prior to the performance of any work that significantly exceeds those estimates in time or cost.

______ Date ______

Technician ______

Supervisor ______

Unit 5-C, Job Ticket for Job Sheet 2

DT:B-C-193